## Other Resource Considerations

## PHYSICAL ENVIRONMENT

## *Karst*

### *Introduction*

Karst is a comprehensive term that applies to the unique topography, surface and subsurface drainage systems, and landforms that develop by the action of water on soluble rock (primarily limestone and marble (carbonates)) in Southeast Alaska. The dissolution of the rock results in the development of internal drainage, producing sinking streams (streams that sink into the stream bed or karst features), closed depressions, sinkholes, collapsed channels, micro-relief karst features, and caves.

The geology and climate of Southeast Alaska are particularly favorable for karst development. Extensive areas of very pure carbonate (>95 percent $CaCO_3$) (Maas et al. 1992), approximately 537,588 acres (840 square miles), are found within the boundaries of the Tongass National Forest. This includes carbonate bedrock on private, State, and Federal lands. Because of fractures in the carbonates, high annual precipitation, and peatlands adjacent to the carbonate bedrock, karst has developed, to varying extent, within all carbonate blocks. The Tongass National Forest contains the largest known concentration of limestone dissolution caves in Alaska.

### *Affected Environment*

In Southeast Alaska the karst landscape can be characterized as an ecological unit found on top of carbonate bedrock in which karst features and drainage systems have developed as a result of differential solution by surface and groundwater. These acidic waters are a direct product of abundant precipitation and passage of these waters through the organic-rich forest soil and the adjacent peat lands. Recharge areas may be on carbonate or adjacent non-carbonate substrate. A few characteristics of this ecological unit include: mature, well-developed spruce and hemlock forests along valley floors and lower slopes, increased productivity for plant and animal communities, extremely productive aquatic communities, well-developed subsurface drainage, and the underlying unique cave resources (Baichtal and Swanston 1996; Wissmar et al. 1997; Bryant et al. 1998). Approximately 1 percent of the Big Thorne project area is underlain by limestone or marble containing karst development. These outcrops comprise the limestone associated with the Luck Creek Breccia, the Heceta Limestone, or the Wadleigh Limestone. Some of these limestones are re-crystallized to marble. Karst landforms and drainage systems have developed within the recrystallized limestone outcrops to varying extent. Karst areas exist mainly in the vicinity of Baird Peak and Control Lake.

The overall amount of karst development located within the project area is very small. The Big Thorne project area is predominantly underlain by Ordovician to Silurian aged andesitic breccias, andesitic and basaltic lavas and graywacke turbidites, conglomerate, sandstone, chert, and shale that have been intruded in the east by Permian diorite (Figure

KST-1). These rocks generally outcrop as dark-gray, greenish-gray, to black blocky, weather-resistant topographic highs and cliffs. Minor recrystallized limestone reefs are scattered throughout the volcanic breccias and flows. Younger, Tertiary sandstones and volcanic rocks are found as small exposures along Lava Creek and the Thorne River in the southeastern portion of the project area. Permian diorite has intruded these rocks to the eastern portion of the project area.

The andesitic breccias, andesitic and basaltic lavas and graywacke turbidites, conglomerate, sandstone, chert, and shale outcrops resisted the scouring efforts of the past glaciation and form the highlands in the eastern two-thirds of the project area. Of these, the conglomerates, sandstones, and shale locally weather to form soil. The carbonaceous shale and thin-bedded cherts weather to form fine, silty soil and are prone to erosion and mass wasting. The volcanic rocks are weather resistant and contribute little soil development. The breccias and conglomerates are well indurated and weather much like the volcanic flow rock. Beneath cliffs of these materials are colluvial deposits. Here these rock types weather to form course-grained complexes with fine-grained interstitial soils. Locally metamorphosed volcanic and sedimentary rocks adjacent to the intrusion weather rapidly and are prone to erosion and mass wasting. In places, the diorite weathers to a granular soil and clays prone to erosion and mass wasting.

## Karst Vulnerability

Karst lands present land management challenges not encountered in non-karst areas because this three-dimensional landform functions differently than other landforms. Karst resources must be evaluated according to their vulnerability to land uses affecting karst systems. Vulnerability mapping recognizes that some parts of the karst landscape are more sensitive than others to surface activities and groundwater contamination. These differences in vulnerability may be a function of the extent of karst development, the openness of the karst systems, and the sensitivity of other resources that benefit from karst groundwater systems (USDA Forest Service 2008a).

### *Low Vulnerability Karst Lands*

Low vulnerability karst lands are those areas where resource damage threats associated with land management activities in the areas are not likely to be appreciably greater than those posed by similar activities on non-carbonate substrate.

A generalized characterization of these lands would be that they are underlain by carbonate bedrock that is moderately well to well drained, most commonly internally drained, but surface streams may be present. Generally, these areas have been greatly modified by glaciation, and a deep (greater than 40 inches deep) covering of glacial till or mineral soil, and little or no epikarst (the upper/outer layer of karst rock in the unsaturated zone, immediately below the soil layer) showing at the surface. The epikarst may be buried and/or ground off, depending on the intensity of glaciation. These lands pose little or no threat to organic, sediment, debris, or pollutant introduction into the karst hydrologic systems beneath through diffuse recharge. Often these are areas of little or no slope (less than 20 percent).

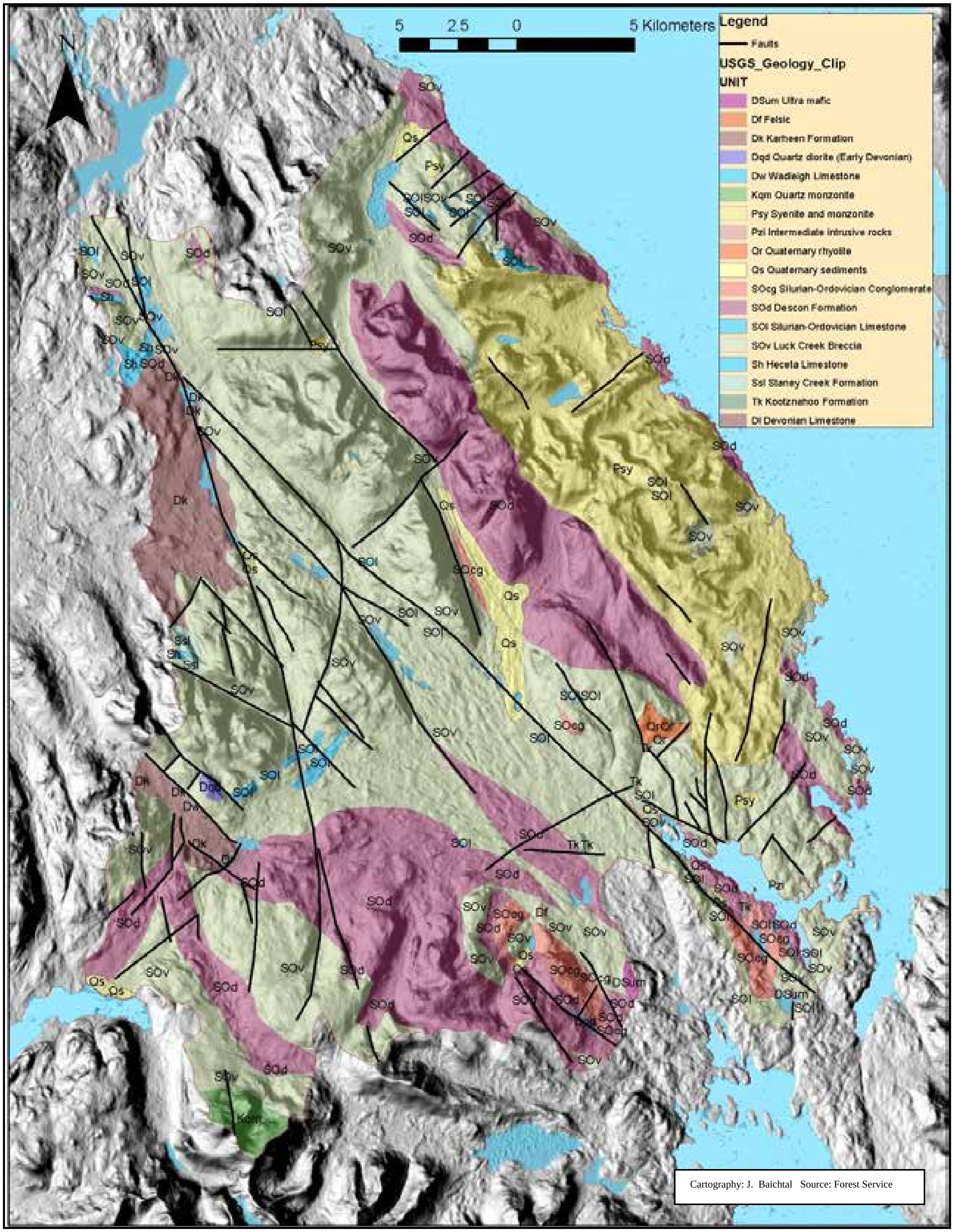


**Figure KST-1.** Geologic Map of the Big Thorne Project Area

### *Moderate Vulnerability Karst Lands*

The moderate vulnerability karst lands are those areas where resource damage threats associated with land management activities in the areas are appreciably greater than those posed by similar activities on low vulnerability karst lands.

A generalized characterization of these areas would be areas underlain by carbonate bedrock that are well drained internally. Surface streams are rare. The soils of moderate vulnerability areas are a mosaic of shallow organic (20 to 40 percent, McGilvery soils) and mineral (80 to 60 percent, Sarkar [less than 20-inch depth] and Ulloa [greater than 20-inch depth] soils) with minor amounts of glacial till. The epikarst is moderate- to well-developed and is visible at the surface. These areas tend to be at higher elevations (i.e., greater than 500 feet, and on knobs, ridges, and on the dip-slope of carbonate bedding planes when near the surface). The surface of these areas tends to be irregular and undulating, following the epikarst development, which is the result of solution of the bedrock surface rather than solution and/or collapse features such as sinkholes.

### *High Vulnerability Karst Lands*

The high vulnerability karst lands are those areas where resource damage threats associated with land management activities are appreciably greater than those posed by similar activities on low or moderate vulnerability karst lands. These are the areas contributing to or overlying significant caves and areas containing a high density of karst features.

These are areas underlain by carbonate bedrock that are well drained internally. Surface streams are rare. Karst systems and epikarst are extremely well developed and collapse karst features may be numerous. These include all collapse karst features, caves, sinking or losing streams, insurgences, open resurgences, and open grikelands (i.e., those without soil or moss infilling and with open connections to the subsurface). The highest vulnerability features are those that could produce and transport the greatest amount of sediment, debris, and/or organics if disturbed. These include till-lined sinkholes and cave entrances accepting a sinking stream, whether intermittent or not. Also considered high vulnerability are karst lands in which the epikarst is well or extremely well developed and the soils are predominantly (greater than 50 percent) very shallow organic (less than 10 inches deep, McGilvery) and (less than 50 percent) mineral (less than 20 inches deep, Sarkar). The subsurface drainage network is highly vulnerable to sediment, organic matter, logging debris, and other pollutants generated as the result of surface activities.

On areas labeled as high or moderate vulnerability there may be features that require buffering under Forest Plan standards and guidelines. These buffers are drawn as a 100-foot radius buffer. However, these buffers may need to be designed and laid out with a karst specialist during unit layout to account for factors such as aspect, slope, windthrow potential, soils, etc., so that buffers may be modified to respond to these conditions.

## Existing Condition

Approximately 8 percent or 245 acres of carbonate bedrock in the Big Thorne project area has been harvested historically. Where karst systems have developed adjacent and beneath harvested areas, it is possible that sedimentation and slash from prior harvest washed into karst features, altering the ecology of the karst system through affecting the water chemistry and flow paths (Aley et al. 1993). It is also possible that in areas that have already been harvested, thickly regenerated forests are causing increased interception rates resulting in less water moving through the karst systems. Without the natural flow rates through the system, slash and debris will remain instead of being washed out. In addition, decreased water flow downstream from these karst areas results in a reduction of fish habitat where karst streams contribute to fish streams (Bryant et al. 1998). High and moderate vulnerability karst are most susceptible to these effects, as outlined in the prior section.

## Environmental Consequences

### Alternative 1 – No Action

The No-action Alternative is just as stated. If this alternative is chosen, no harvest would occur within the project area under the Big Thorne Project. No other projects are currently planned to occur on karstlands.

#### *Direct and Indirect Effects*

There would be no direct or indirect effects on the karst resource by not harvesting in the Big Thorne project area.

#### *Cumulative Effects*

Effects from past harvest and natural processes in the Big Thorne project area such as sedimentation and erosion would experience no beneficial or adverse change, but would continue at the present rate.

### Alternatives 2, 3, 4, and 5

#### *Harvest on Karst*

Total harvest on karst acreages per alternative are shown in Table KST-1. Under no alternative is there greater than a 0.5 percent change in the percent harvest on karst relative to the existing condition of the karst resource of the project area. High vulnerability karst areas have been removed from proposed harvest units, as described in the unit cards (Appendix B of the Draft EIS; FEIS unit cards are in the project record). Specific harvest requirements for units containing moderate and low vulnerability karst are outlined in the unit cards. Harvest prescriptions are discussed alternative by alternative under the specific unit addressed in the mitigation and monitoring section.

**Table KST-1.** Changes to Total Harvest on Karst for the Big Thorne Project Area

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 |
|---|---|---|---|---|---|
| Acres of Previous Harvest on Karst | 245 | 245 | 245 | 245 | 245 |
| Percent Karst Acres Harvested Historically[a] | 8% | 8% | 8% | 8% | 8% |
| Acres of Proposed Harvest on Low Vulnerability Karst | 0 | 0 | 11.2 | 11.2 | 11.2 |
| Acres of Proposed Harvest on Moderate and High Vulnerability Karst | 0 | 0 | 0 | 0 | 0 |
| Acres Thinning in Previous Harvest on Karst | 0 | 8.7 | 8.7 | 8.7 | 8.7 |
| Total Acres Proposed Harvest and Thinning on Karst | 0 | 8.7 | 19.9 | 19.9 | 19.9 |
| Total Acres Harvest on Karst | 245 | 245 | 256 | 256 | 256 |
| Percent Change | 0% | 0% | 0.5% | 0.5% | 0.5% |

Table based on data from the Tongass geology layer and the Big Thorne unit layer - data current September 20, 2011.

### Roads on Karst

There are no proposed roads on karst areas in the Big Thorne Project. Road building on high vulnerability karst would be avoided under all alternatives. Specific requirements concerning road building on moderate vulnerability and high vulnerability karst are located in the Forest Plan (Appendix H, section III.A.4.b.ii).

### Direct and Indirect Effects for all Action Alternatives

The lowest acreage of karst proposed for harvest is Alternative 2 with no harvest or thinning on karst. Alternatives 3, 4, and 5 would conduct 11.2 acres of new harvest on low vulnerability karst (Table KST-1) and 8.7 acres of thinning on karstlands that were previously harvested. The effects are expected to be minor with all alternatives because of removing high vulnerability karst areas from proposed harvest units and protecting soil and water quality in low vulnerability areas by specifying suspension requirements in the unit cards. Effects could include initial increase in flow through karst systems after initial harvest in low and moderate vulnerability karst areas and subsequent (approximately 5 years post-harvest) decrease to flow through these karst systems due to dense forest regeneration (Aley et al. 1993). Increase to turbidity and changes in water chemistry through the karst system could also occur due to these changes in flow (Aley et al. 1993). Also see Baichtal and Swanston (1996) and Baichtal (1997) for more detailed descriptions of effects.

The standards and guidelines of the amended Forest Plan are based on these studied and documented direct, indirect, and cumulative effects. The Karst Standards and Guidelines are applied in this project to mitigate the direct, indirect, and cumulative effects to the karst resource of the Big Thorne project area. Detailed site-by-site mitigation is prescribed, where necessary, in the unit and road cards (Appendices B and C).

### Cumulative Effects

Alaska Forest Highway 33 (the Coffman Cove Road) was paved during the summer of 2011 in the project area. This road construction did not significantly affect karst in the project area, or in affected watersheds in the project area.

Cumulative effects from harvesting additional karst areas in the project area would not be significant since the Karst Standards and Guidelines will be applied as described in the unit cards (Appendix B of the Draft EIS; FEIS unit cards are in the project record), roads cards (Appendix C of the Draft EIS; FEIS road cards are in the project record), and in the “Mitigation” section.

### Mitigation for Alternatives 2, 3, 4, and 5

Portions of a number of the original units were identified as high vulnerability karst. As a result, these areas were deleted from the units or the units were dropped. No special prescription is required for areas on low vulnerability karst.

# Soils

## Introduction

This section provides a summary of the soil resources in the Big Thorne project area. Forest-wide standards and guidelines for this resource are on pages 4-64 through 4-67 of the Forest Plan. The analysis and results presented in the environmental consequences section are based upon proposed harvest unit boundaries and the overall project area boundary. The analysis for the soils resource uses both temporary and NFS road information. Detailed discussion of the soil and wetlands of the Big Thorne project area can be found in the Soil and Wetland Resources Report (Cox et al. 2013) in the Big Thorne Project record.

Timber harvest can adversely affect the soils resource by:

- Disturbing, displacing, or burying the nutrient-rich forest floor and exposing mineral soils to erosion, and
- Increasing the frequency of landslides which also displace nutrient rich soils and increase erosion potential.

### Resource Analysis Area

The boundary selected for the following analysis of soils is the same as the Big Thorne project area. The project area is about 231,848 acres, including 217,679 acres of NFS lands and 14,169 acres of State and private lands. Soil types and physical properties are described for the project area.

The analysis area for direct, indirect and cumulative effects to soils includes the “activity area” (FSM 2554). For this project, the “activity area” includes individual proposed timber harvest units and associated land impacted by temporary road construction. The Forest Service Manual limits the amount of detrimental (long-term) soil disturbance to activity areas. FSM 2554 requires that a minimum of 85 percent of an area remain in a condition of acceptable productivity potential for trees and other managed vegetation.

The direct and indirect effects of the Big Thorne Project to the soil resource include landslides and other long-term (detrimental) soil disturbance that are a result of temporary road construction and harvest activities. The unit of measure for the soil analysis is acres of detrimental soil disturbance due to temporary road construction, yarding activities, and management-related landslides. The temporal extent of effects to soil is decades or longer due to the length of time it takes for soils to recover and regenerate vegetative cover after clearing.

Detailed discussion of the soil resource and analysis methods can be found in the Soil and Wetland Resources Report (Cox et al. 2013) in the Big Thorne Project record.

## Affected Environment

The project area is located within the Central Prince of Wales Volcanics and the Till Lowlands ecological subsections (Nowacki et al. 2001). Within the volcanic mountain ecological subsection, most rock outcrops are volcanic rocks; glacial tills soils are common at low elevations (USDA Forest Service 2001a). Within the Central Prince of Wales Till Lowlands, organic soils overlay glacial till (USDA Forest Service 2001a).

Project area soils range from very poorly drained to well-drained soils. Very poorly drained soils (38 percent) are mostly organic and typically have low productivity and support muskeg vegetation. Other soils in the project area include poorly drained (20 percent), moderately well drained (22 percent), and well drained (17 percent); the remaining 3 percent of the project area is mapped as fresh or salt water, rock outcrops, or small islands. Moderately well- and well-drained soils typically support productive forests. Most soils in the project area have a thick organic or duff layer that prevents erosion of the underlying mineral soil from raindrop impact and supplies many nutrients for plant growth. Keeping the organic mat in place during management activities is a key to maintaining soil productivity. Windthrow is the dominant disturbance factor on slopes exposed to southern aspects. Landslides are the dominant disturbance factor on steep wind-protected slopes. Gently sloping lowlands are present along the valley bottoms and support wetland vegetation.

The soils on the Big Thorne project area are mostly in natural condition. Past management activities on NFS and non-NFS lands include about 49,594 acres of timber harvest, resulting in about 1,488 acres of detrimental soil disturbance. In addition, 580 miles of road construction (includes past temporary, NFS, State, decommissioned, and private and local) and associated rock quarry development have occurred within the project area. Existing soil disturbances (natural and management related) on the Big Thorne project area are summarized in Table SOIL-1.

Management activities have caused past soil disturbances. Existing management-related detrimental soil disturbance is estimated to be about 3,511 acres or 1.5 percent of the project area. These past disturbances are considered to be minor and currently have minimal erosion concerns. In the Big Thorne project area, natural and management-related soil disturbances are within parameters found in Region 10 Soil Quality Standards at the project area scale. The following sections describe the natural and management-induced soil disturbances in detail.

## Natural Disturbances

Natural soil disturbances on the project area include areas such as erosion from overland flow, stream bank erosion, windthrow, and colluvial activity. These natural soil disturbances, excluding natural landslides which are discussed below, are estimated to occur over about 1,814 acres in the project area.

The project area is exposed to high-wind events that lead to windthrow. Numerous areas have experienced windthrow and are at risk for future events. Windthrow may also lead to landslide activity on shallow soils present on steep forested slopes (Swanston 1967). However, windthrow may play an important role in the soil disturbance and nutrient cycling regime of some soils on the project area. Nutrients tend to accumulate and become immobilized in organic and upper layers of the soil which can lead to nutrient deficiency in areas where minimal windthrow disturbance or other soil disturbance mechanisms are present (Bormann et al. 1995). Windthrow can provide mixing and aeration of the organic and mineral soil horizons, freeing nutrients to be used by plants, thus increasing soil productivity.  Conversely, Stephens et al. (1968) found that stands regenerated from windthrow had a site index that was about 20 feet less than in stands originating following clearcutting or fires.

**Table SOIL-1.** Existing Soil Disturbance in Big Thorne Project Area

| Soil Disturbance | Acres Affected | Project Area (%) |
|---|---|---|
| **Management Related Soil Disturbances** | | |
| Past log yarding activities[1/] | 1,488 | 0.6% |
| Existing acres of NFS road (375 miles) | 1,818 | 0.8% |
| Existing acres of FS decommissioned road (117 miles) | 567 | 0.2% |
| Existing acres of other roads[2/] (88 miles) | 427 | 0.2% |
| Existing rock quarries[3/] | 580 | 0.2% |
| Landslides from past harvest[4/] (241) | 393 | 0.2% |
| Landslides from road construction (61) | 56 | 0.02% |
| Total Soil Disturbances from Management | 5,329 | 2.3% |
| Total Detrimental Soil Disturbances from Management[5/] | 3,510 | 1.5% |
| **Natural Soil Disturbances** | | |
| Naturally occurring landslides (676) | 3,150 | 1.4% |
| Natural soil disturbances [6/] | 1,814 | 0.8% |
| Total Natural Soil Disturbances | 4,964 | 2.1% |
| **Total Existing Soil Disturbance** | **10,293** | **4.4%** |

Notes:
1/ 3% of harvest areas (Landwehr and Nowacki 1999)
2/ Other roads include “Private”, “Unknown”, “Local”, and State.
3/ Assumes 1 acre of disturbance from quarry development for every mile of existing NFS road, FS decommissioned road, and other roads.
4/ These were defined as any landslide where the initiation point of the landslide (or the highest elevation point) fell within a harvest unit (Landwehr 1998, 2011b; Saari 2009).
5/ Does not include NFS roads.  NFS roads are considered facilities and not detrimental soil disturbance.
6/ Defined as 2% of moderately and well drained soils within the project area (Saari 2011; Landwehr and Nowacki 1999).  Calculation included primary and secondary drainage classes for each SMU.
Sums may not match due to rounding.

## Natural and Management-related Landslides

Landslides (mass wasting) are the dominant erosion process in steep forested terrain with high soil water levels in Southeast Alaska (Swanston 1969).  Topographic, geologic, and soil conditions in combination with high amounts of rainfall are the major contributing factors.  The soil mass movement index is a tool used to assess slope stability at the project scale.  Mass movement index (MMI) hazard classes are used to group soil map units that have similar properties relative to the stability of natural slopes.  Four categories of MMI soil hazard classes exist: MMI 1 (most stable) through MMI 4 (least stable). Soils with a very high mass movement index (MMI 4) have the greatest probability for slope failure.

A landslide inventory was completed for the project area using aerial photography and field observations.  Each landslide was associated with the MMI class where it was initiated as shown in Table SOIL-2.  Table SOIL-2 indicates that 978 landslides have disturbed about 3,597 acres across the project area.  Most of these slides initiated in MMI 3 and 4 (50 percent and 31 percent, respectively).

**Table SOIL-2.** Total Mapped Landslides within the Big Thorne Project Area

| Mass Movement Index Class | Acres of MMI Class | Number of Landslides | Approx. Acres of Landslides |
|---|---|---|---|
| Initiated in MMI 1 | 101,245 | 147 | 1,260 |
| Initiated in MMI 2 | 20,022 | 32 | 37 |
| Initiated in MMI 3 | 85,913 | 491 | 745 |
| Initiated in MMI 4 | 20,223 | 308 | 1,555 |
| Other[1] | 4,446 | -- | -- |
| **Total[2]** | **231,848** | **978** | **3,597** |

1/ Project area also includes 4,446 acres of water and other minor areas with no MMI mapping.
2/ Numbers in the table may not sum exactly due to rounding.

Landslides occurring within the Big Thorne project area over the last 40[1] years were assessed to compare landslides occurring in unharvested areas and landslides associated with management practices as shown in Table SOIL-3. During this 40-year period, 209 natural landslides occurred in productive old growth (POG), disturbing about 194 acres of soil, and averaging less than 1 acre in size. In this same 40-year time period, 200 landslides occurred within previously harvested areas disturbing about 276 acres of soils, and averaging about 1.4 acres in size. The majority of all landslides initiated in MMI 3 and MMI 4 soils and these classes had a much higher rate of landslide initiation per unit area. Also, note that most landslides indicated by GIS as having initiated in MMI 1, actually initiated just outside of MMI 1 polygons in higher-risk areas, or represent minor GIS mapping errors in the mass movement index layer.

**Table SOIL-3.** Landslides in Harvested Areas and Non-Harvested POG during the Past 40 Years (1971-2010)

| Category | Total Acres | Number of Landslides | Approx. Acres of Landslides |
|---|---|---|---|
| **Natural Landslides** | | | |
| Landslides in Unharvested POG | 98,654 | 209 | 194 |
| **Management-related Landslides** | | | |
| Harvest Areas | 49,594 | 200 | 276 |
| Roads | | 55 | 48 |
| **Forty-Year Totals** | | **464** | **518** |

Note: Does not include landslides outside of productive old growth.
Total acres are NF harvest only and do not include State and private land harvesting.
These data only consider landslides that have occurred after 1971; as a result, the number and acres of landslides presented here do not match those presented in Table SOIL-1, which includes pre-1971 landslides.

When the Big Thorne project area landslide inventory data are compared on a landslide per acre basis, the data indicate that landslides in harvested areas (200 landslides in 49,549 acres of harvest areas) are approximately 1.9 times more likely to occur than landslides in POG areas (209 landslides per 98,654 acres of POG). The increased occurrence of landslides in harvested areas may be attributed to management practices. Decreased rainfall interception may result in increased soil water content and pore pressure; removal of the protective organic mat exposes soil to erosion; and soil stability decreases as roots decay in the years following harvest. Other studies have shown that clearcut timber

[1]Based on dates in GIS landslide inventory, not including pre-1971.

harvests resulted in 3 to 10 times more landslides than uncut areas (Swanston and Marion 1991; Bishop and Stevens 1964; Landwehr 1994, 1998), several of which included all or part of the Big Thorne project area.

A total of 55 road-related landslides have been recorded during this same 40-year period and have affected about 48 acres, averaging about 0.9 acre per landslide (Table SOIL-3). Road-related landslides are generally the result of ditches concentrating water and delivering it to a naturally unstable area of the slope or by excessive road fill weight on a naturally unstable slope (Landwehr 1998).

### Management-related Disturbances

#### *Past Harvest Activities*

Soil disturbances associated with past harvest activities have typically been the result of road construction and log yarding. Total past harvest in the project area is approximately 49,594 acres. Harvest entries prior to 1980 accounted for about 29,096 acres. Harvest entries in the 1960s accounted for about 19,191 acres, or 39 percent of all harvest. Since the late 1970s, yarding methods used suspension techniques that provided partial suspension of logs and full suspension in some cases. These yarding techniques greatly minimized potential for soil disturbances when compared to non-suspension techniques. Soil disturbances from past yarding activities in the project area are estimated to total about 1,488 acres. The estimated acres of disturbed soil associated with past harvest assumes a 3 percent disturbance of all harvest areas based on soil disturbance monitoring data summarized by Landwehr and Nowacki (1999).

#### *Road Construction*

Soil disturbances associated with road construction (includes NFS and State, decommissioned, and private roads) cover about 2,812 acres from about 580 miles of road in the project area (based on a 40-foot-wide disturbed soil corridor); however, disturbance associated with NFS roads does not count towards detrimental soil disturbance. Soil disturbances from road construction involve removing the nutrient-rich organic layer to shape cutslopes and burying some areas of productive soil under shot rock. Overlay road construction has been commonly used on nearly level or gently sloping poorly drained soils in wetland areas. Overlay road construction does not impact as large an area of soil as cut-and-fill road construction.

Additionally, numerous rock quarries were developed to build these roads. In rock quarries, soils are removed to expose the bedrock and are stacked adjacent to the quarry, burying other productive soils. Assuming 1 acre of disturbance from quarry development for every mile of road (including those that are decommissioned, past development of rock quarries has resulted in an estimated 580 acres of detrimental soil disturbance.

As noted above, 55 road-related landslides have been recorded during a 40-year period and have affected about 48 acres, averaging about 0.9 acre per landslide.

#### *Harvests on Slopes Greater Than 72 Percent*

Past harvest activities have avoided most slopes greater than 72 percent gradient. The digital elevation model for the project area when overlain with the managed stands layer indicates approximately 965 acres (2 percent of harvested areas in the project area) of slopes greater than 72 percent gradient have been harvested. Based on the evaluation presented in the Watershed Resource Report (James 2013), harvest has occurred on slopes greater than 72 percent in 14 out of 21 watersheds. Of the watersheds within the soils analysis area, the percent acres harvested on slopes greater than 72 percent was greater than 3 percent in the Ratz Creek and Rio Beaver Creek watersheds. Management-related landslides have occurred in these watersheds. There were approximately 643 acres of landslides (management and natural) in the Ratz Creek watershed, of which 212 acres were on slopes greater than 72 percent. There were 199 acres of landslides in the Rio Beaver Creek watershed, of which 56 acres were on slopes greater than 72 percent. Most landslide activity resulting from harvesting and roads occurred before current Forest Plan standards and guidelines were implemented. Therefore, past effects are likely to be greater than those that have occurred following more recent timber harvests using modern BMPs and those that would occur under future harvests.

## *Environmental Consequences*

### Direct and Indirect Effects

Data used for soil analysis come from existing resources such as the Soil Resource Inventory, the landslide inventory, the digital elevation model, and field data collected through on-site surveys conducted in support of this project. Road acres are based on an average road width of 40 feet (from top of cutslope to toe of fillslope). Effects are compared between the alternatives based on the following measurements and estimates:

- Acres of detrimental soil conditions in harvest units due to temporary road construction and yarding activities,
- Acres of proposed timber harvest on slopes 72 percent or greater,
- Acres of road (existing and proposed NFS and temporary) on slopes 67 percent or greater,
- Acres of future landslides acres as a result of management activities based on the project area landslide inventory, and
- Cumulative acres of soil removed from productivity by roads, detrimental soil conditions within harvest units, and landslides.

#### *Soil Productivity*

Region 10 Soil Quality Standards state that a minimum of 85 percent of an area should be left in a condition of acceptable productivity potential for trees and other managed vegetation following land-management activities. Detrimental soil conditions are defined in FSM 2554. Detrimental soil areas are areas of soil that have been altered to the point where soil productivity has been affected. Detrimental soil conditions are typically associated with road construction, log felling, and log yarding. Soil disturbances associated with NFS road construction are not counted toward detrimental soil conditions because system roads are removed from the productive land base. Temporary roads are considered part of the land base and are included in the calculation of detrimental soil conditions.

Detrimental soil conditions are calculated for two areas – the activity area, which includes the harvest units and associated temporary roads, and the overall project area. Detrimental soil conditions incurred by proposed harvest activities such as tree felling and yarding include soil displacements, a loss of ground cover, compaction, and soil puddling. This analysis of detrimental soil conditions in harvest units is based on soil quality monitoring data collected on the Tongass as reported by Landwehr and Nowacki (1999). This analysis assumes 3 percent detrimental soil condition for areas where partial suspension or shovel yarding is proposed and 2 percent detrimental soil condition where full suspension is proposed. Table SOIL-4 displays the estimated acres of detrimental soil conditions resulting from the implementation of the alternatives.

**Table SOIL-4.** Estimated Acres of Detrimental Soil Conditions from Implementation of the Alternatives[6/]

| Category | Alt. 1 No Action | Alt. 2 Proposed Action | Alt. 3 | Alt. 4 | Alt. 5 |
|---|---|---|---|---|---|
| New proposed temporary road construction (acres)[1/] | 0 | 95 | 123 | 16 | 39 |
| Rock quarry development for new road construction (acres)[2/] | 0 | 26 | 37 | 3 | 9 |
| Yarding disturbances in Harvest Units (acres)[3/] | 0 | 135 | 252 | 162 | 181 |
| New management-related landslides (next 30 years)[4/] | 0 | 25 | 46 | 33 | 36 |
| **Total acres of new detrimental soil condition**[5/] | **0** | **281** | **458** | **214** | **265** |

Notes:
1/ New road construction is based upon 40-foot disturbed soil corridor.
2/ A 1-acre rock quarry has been estimated for every 1 mile of new road construction (excluding construction on decommissioned road grades).
3/ Yarding disturbances based on an estimate of 3% of the harvest area where partial suspension or shovel yarding is proposed and 2% where full suspension is proposed; excludes temporary roads.
4/ Landslide acre estimate based on past landslide inventory projected for 30 years into the future.
5/ Detrimental soils conditions based on proposed timber harvest acres and do not include deferral acres.
6/ Numbers in the table may not sum exactly due to rounding.

Table SOIL-4 data indicate that Alternative 3 would result in the greatest impact to soil productivity. Of the action alternatives, implementation of Alternative 4 would result in the least amount of detrimental soil conditions; however, the results are similar for Alternatives 2 and 5. A detailed analysis of estimated soil disturbance for each proposed harvest unit has been conducted and is included in the Big Thorne Project record. The evaluation of detrimental soils disturbance from proposed temporary roads, rock quarries, and harvest indicate that every alternative will meet Region 10 Soil Quality Standards for soil productivity on a project area scale. When the evaluation includes existing detrimental soil disturbance, including previous management-related landslides, harvest, and decommissioned roads, available data indicate that all units meet the Region 10 Soil Quality Standards.

### *Harvest on Slopes Greater than 72 Percent*

All proposed old-growth harvest units with slopes exceeding 50 percent were field reviewed for slope stability. Areas with very high risk of mass movement were excluded from timber harvest. Slopes greater than 72 percent in young-growth units will be field reviewed for suitability prior to implementation. Boundaries are modified on areas with concerns about slope stability and impacts to soil productivity following harvest. Landslide-prone slopes are removed from harvest consideration to protect soil resources and prevent potential degradation of downslope resources. Slopes greater than 72 percent are identified within units in the project area, and excluded from harvest if unstable. In total, across the project area, approximately 1,996 acres were deemed unstable and excluded from the harvest units. Most of these areas were on slopes greater than 72 percent. In addition, harvest prescriptions and suspension requirements are determined for other steep slope areas. Complete details are included in the soil unit resource reports and in the individual unit cards (in the Big Thorne Project record).

Approximately 222 acres of slopes greater than 72 percent gradient remain in the unit pool because they rate well below MMI 4 landslide potential. Most areas are less than 5 acres in size and consist of short steep slopes associated with rock outcrops. Units 37, 158, 201, 202, 394, 545, 546, 550, and 551 include greater than 5 acres total of harvests on slopes greater than 72 percent. Harvest areas on slopes greater than 72 percent are included in the proposed harvest units because they appear stable and will facilitate yarding of surrounding lesser slopes. Appropriate mitigation measures are prescribed in the unit cards. Complete details are included in the soil stability investigation reports (in the Big Thorne Project record) and/or unit cards.

Table SOIL-5 displays the proposed acres of slopes greater than 72 percent gradient that remain in the unit pool, and the proposed harvest systems on those slopes, for each alternative. The areas in Table SOIL-5 meet the criteria for timber harvest on slopes greater than 72 percent gradient as defined by the Forest Plan. The majority of these units are proposed for helicopter yarding with partial retention. Partial cutting in these helicopter units would help ensure an adequate amount of live root mass remains intact to preserve slope stability. Less soil disturbance in a harvest unit results in less disruption of the root mat and subsequently more root strength than if the soil is disturbed (Swanston 1974).

**Table SOIL-5.** Proposed Harvest Unit Acreage with Slopes Greater than 72% that Meet the Slope Stability Analysis Criteria for Timber Harvest (old-growth harvest and young growth thinning[1,2,3/])

| Proposed Harvest System | Alt. 2 Slopes | | Alt. 3 Slopes | | Alt 4. Slopes | | Alt. 5 Slopes | |
|---|---|---|---|---|---|---|---|---|
| | OG Harvest | YG Thinning | OG Harvest | YG Thinning | OG Harvest | YG Thinning | OG Harvest | YG Thinning |
| Ground | 1 | 0 | 1 | <1 | 1 | <1 | 1 | <1 |
| Cable | 15 | 0 | 19 | 121 | 4 | 109 | 6 | 103 |
| Helicopter | 49 | 0 | 67 | 0 | 67 | 0 | 65 | 0 |
| **Total** | **64** | **0** | **87** | **121** | **72** | **109** | **72** | **103** |
| **% Partial Harvest** | **46%** | **N/A** | **54%** | **100%** | **90%** | **100%** | **72%** | **100%** |

Notes:
1/ Field verification of young-growth stands was not completed as of this writing. Acres of harvest on slopes over 72% based on field collected data for old-growth and 20 meter DEMS for young-growth. After it is completed prior to implementation, it is likely that additional area will be dropped from young-growth areas.
2/ Total numbers may not match sum exactly due to rounding
3/ Areas with steep slopes that will utilize ground based equipment are short rock outcrops that average less than 1 acre in size and can be operated around.
OG = old growth; YG = young growth

Alternative 2 has the least acreage of harvest on slopes greater than 72 percent and Alternative 3 has the most acreage for both old-growth harvest and young-growth thinning. Most areas with slopes greater than 72 percent that are included in proposed harvests are associated with rock outcrops that average less than 1 acre in size and can be operated around.

The Mitkof Highway assessment (Swanston 2006) was considered during this analysis. The slope stability factors considered in the Mitkof slope stability assessment are the same factors considered in the slope stability assessment for the Big Thorne harvest units. Those factors are also described in the 2008 Forest Plan. The downslope resources at risk in the Mitkof assessment are very different than the downslope resources at risk on the Big Thorne project area. The soils and site factors are somewhat different between the two project areas. The mitigation described for the Big Thorne harvest units is appropriate when considering the soil and site factors and the downslope resources at risk.

Roads and landings have been located to avoid slopes greater than 67 percent, on unstable slopes, or in slide-prone areas, to the extent feasible. All roads proposed on slopes over 67 percent were field reviewed for slope stability and the steep slopes were either avoided or appropriate mitigation measures assigned (see road cards). Cumulatively, less than a 0.1 mile of road is planned on slopes over 67 percent. It is likely that the location of roads will be adjusted prior to implementation. The Forest Plan directs to avoid locating roads on a slope greater than 67 percent, on an unstable slope, or in a slide-prone area, where feasible.

### *Alternative 1*

Under Alternative 1, no timber harvest or road building would take place and no soil disturbances would be caused by new management activities associated with the Big Thorne Project. No rehabilitation efforts involving road construction, storage, and decommission would be completed on existing roads under this project. Roads on the project area will continue to receive incidental use from hunters and other visitors. Landslides would continue to occur in unharvested areas and existing harvested areas. Vegetation in harvested areas would continue to grow and add stability to soils on those sites. Detrimental soil conditions would remain within Region 10 Soil Quality Standards.

### *Alternative 2*

Alternative 2 proposes approximately 5,121 acres of old-growth timber harvest. Approximately 1,904 acres would be helicopter yarded, 1,341 acres cable yarded, and 1,875 acres shovel yarded under minimum partial suspension requirements. This alternative includes about 24 miles of new temporary road construction or construction on decommissioned road grades, and 8 miles of proposed NFS roads. Construction of 20 miles of new temporary road (excluding construction on decommissioned road grades) would result in approximately 95 acres of soil disturbance. Additionally, rock quarry development would result in about 26 acres of disturbance based on 26 miles of new temporary and NFS roads (excluding construction on decommissioned road grades). About 135 acres of soil disturbance would result from harvest and approximately 25 acres of management-related landslides are projected to occur over the following 30 years as a result of this alternative. Total area of soil with reduced productivity would be approximately 281 acres (see Table SOIL-4). All harvest units in Alternative 2 would meet Region 10 Soil Quality Standards.

Approximately 64 acres of slopes greater than 72 percent gradient would be harvested in Alternative 2. Alternative 2 includes the lowest amount of timber harvest proposed on slopes greater than 72 percent of any action alternative (Table SOIL-5). All proposed old-growth harvest units with slopes exceeding 50 percent were field reviewed for slope stability and will meet the requirements set forth in the Forest Plan.

### *Alternative 3*

Alternative 3 proposes approximately 9,419 acres of timber harvest, of which 7,120 acres is old growth and 2,299 acres is young-growth thinning. Of the old-growth harvest, approximately 3,018 acres would be helicopter yarded, 1,763 acres cable yarded, and 2,338 acres shovel yarded under minimum partial suspension requirements. This alternative includes about 37.5 miles of new temporary road construction or construction on decommissioned road grades and about 14 miles of proposed NFS roads. Construction of 25 miles of new temporary road (excluding construction on decommissioned road grade) would result in approximately 123 acres of soil disturbance. Additionally, rock quarry development would result in about 37 acres of disturbance based on about 37 miles of new temporary and NFS roads (excluding construction on decommissioned road grade). About 252 acres of soil disturbance would result from harvest and approximately 46 acres of management-related landslides are projected to occur over the following 30 years. Total area of soil with reduced soil productivity would be approximately 458 acres (see Table SOIL-4). All harvest units would meet Region 10 Soil Quality Standards at the unit scale.

Approximately 208 acres of slopes greater than 72 percent gradient would be harvested in Alternative 3. Alternative 3 includes the greatest amount of timber harvest proposed on slopes greater than 72 percent of any alternative. All proposed old-growth harvest units with slopes exceeding 50 percent were field reviewed for slope stability. Field verification of young-growth stands occurred to verify detrimental soil conditions. Slopes greater than 72 percent in young-growth units will be field reviewed prior to implementation. Harvest proposed on slopes greater than 72 percent gradient will meet the requirements set forth in the Forest Plan.

### *Alternative 4*

Alternative 4 proposes approximately 6,645 acres of timber harvest, of which 4,759 is old growth and 1,888 is young-growth thinning. Of the old-growth harvest, approximately 3,720 acres would be helicopter yarded, 331 acres cable yarded, and 706 acres shovel yarded under minimum partial suspension requirements. This alternative includes about 11 miles of new temporary road construction or construction on decommissioned road grades and 0.2 mile of proposed NFS road. Construction of about 3 miles of new temporary roads (excluding construction on decommissioned road grades) would result in approximately 16 acres of soil disturbance. Additionally, rock quarry development would result in about 3 acres of disturbance based on about 3 miles of new temporary and NFS roads (excluding construction on decommissioned road grades). About 162 acres of soil disturbance would result from harvest and approximately 33 acres of management-related landslides are projected to occur over the next 30 years. Total area of soil with reduced productivity would be approximately 214 acres (see Table SOIL-4).

All harvest units would meet Region 10 Soil Quality Standards at the unit scale.

Approximately 181 acres of slopes greater than 72 percent gradient would be harvested in Alternative 4 (Table SOIL-5). All proposed old-growth harvest units with slopes exceeding 50 percent were field reviewed for slope stability. Field verification of selected young-growth stands occurred to verify detrimental soil disturbance. Slopes greater than 72% in young growth units will be field reviewed prior to implementation. Harvest proposed on slopes greater than 72 percent gradient will meet the requirements set forth in the Forest Plan.

### *Alternative 5*

Alternative 5 proposes approximately 7,302 acres of timber harvest, of which 5,452 acres are old growth and 1,850 acres are young growth. Of the old-growth harvest, approximately 3,757 acres would be helicopter yarded, 627 acres cable yarded, and 1,068 acres shovel yarded under minimum partial suspension requirements. This alternative includes about 16 miles of new temporary road construction or construction on decommissioned road grades and about 0.8 mile of proposed NFS roads. Construction of about 8 miles of new temporary road (excluding construction on decommissioned road grades) would result in approximately 39 acres of soil disturbance. Additionally, rock quarry development could result in about 9 acres of disturbance based on about 9 miles of new temporary and NFS roads (excluding construction on decommissioned road grades). About 181 acres of soil disturbance would result from harvest and approximately 36 acres of management-related landslides are projected to occur over the following 30 years. Total area of soil with reduced productivity would be approximately 265 acres (Table SOIL-4). All harvest units would meet Region 10 Soil Quality Standards at the unit scale.

Approximately 175 acres of slopes greater than 72 percent gradient would be harvested in Alternative 5. All proposed old-growth harvest units with slopes exceeding 50 percent were field reviewed for slope stability. Field verification of young-growth stands occurred to verify detrimental soil disturbance. Slopes greater than 72 percent in young-growth units will be field reviewed prior to implementation. Harvest proposed on slopes greater than 72 percent gradient will meet the requirements set forth in the Forest Plan.

## Cumulative Effects

The cumulative effects analysis area for soils is the project area. In young-growth stands, where treatments are proposed, cumulative effects to soils were also analyzed at the stand scale (data in project record). All individual stands including those with past treatments, will meet FSM 2554 direction that 85 percent of an activity area be left in a condition of acceptable productivity potential for trees and other managed vegetation.
Cumulative effects of the proposed harvest and road construction/reconstruction on long-term soil productivity are directly related to the amount of soil disturbance that occurs through time because of natural events, temporary road construction, and resource management.

Reasonably foreseeable projects considered include the Roadside micro-sales, remaining Control Lake sales, additional harvests on State lands within the project area identified in the State’s 5-year timber plan, road activities on NFS lands, young-growth treatments on

NFS lands, restoration activities in the project area, and Recreation projects. The State-managed harvests include the Beach Road, North Thorne #3, and North Thorne #4 sales northeast of Thorne Bay and the South Thorne Bay #4 and South Thorne Bay #4 sales on the Kasaan Peninsula.

Because the effects of the present and reasonably foreseeable actions are consistent across all alternatives, the cumulative effects are comparable by alternative. Region 10 Soil Quality Standards require a minimum of 85 percent of the area left for productivity (FSM 2500, R-10 Supplement 2500-2006-1). Table SOIL-6 includes the estimated cumulative detrimental soil disturbance from past, present, and reasonably foreseeable projects within the project area.

Detrimental soil disturbance from the Big Thorne Project and foreseeable actions combined with existing conditions would total to approximately 1.5 to 1.7 percent detrimental soil conditions within the project area under each alternative, meeting the Region 10 Soil Quality Standards at the project area level.

Alternative 1 would not contribute to the cumulative effects of other present and reasonably foreseeable actions on soils. Alternatives 2 through 5 would add the effects as described in the direct and indirect effects section and summarized in Table SOIL-6. Alternative 3 would have the largest cumulative effect on soil resources, the Big Thorne Project adding 458 acres of detrimental soil conditions and other reasonably foreseeable actions adding another 60 acres of detrimental soil conditions. Alternative 4 would have the fewest acres of cumulative detrimental soil conditions, and Alternatives 2 and 5 would have similar acres of cumulative detrimental soil conditions.

**Table SOIL-6.** Estimated Acres of Cumulative Detrimental Soil Disturbance by Alternative

| Detrimental Soil Disturbance | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 |
|---|---|---|---|---|---|
| Total Existing Detrimental Soil Disturbance from Management (acres) | 3,510 | 3,510 | 3,510 | 3,510 | 3,510 |
| Detrimental Soil Disturbance from Big Thorne Project (acres)[1/] | 0 | 281 | 458 | 214 | 265 |
| **Reasonably Foreseeable Actions** | | | | | |
| Roadside EA (micro-sales)[2/] | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Remaining Control Lake Sales (includes roads) | 16 | 16 | 16 | 16 | 16 |
| Harvests on State lands (includes roads)[3/] | 38 | 38 | 38 | 38 | 38 |
| Estimated Predicted Landslides from Harvest on State Lands (over next 30 years)[1/] | 3 | 3 | 3 | 3 | 3 |
| Free Use Timber Sales | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Total Detrimental soil disturbance from Reasonably Foreseeable Actions (acres) | 60 | 60 | 60 | 60 | 60 |
| **Cumulative Soil Disturbance (acres)** [4/] | 3,570 | 3,851 | 4,028 | 3,784 | 3,835 |
| **Cumulative Soil Disturbance (percent of project area)** | 1.5% | 1.7% | 1.7% | 1.6% | 1.7% |

1/ Includes 30 years' worth of management-related landslides at the predicted rate (SOIL-4).
2/ Assumes 3 percent detrimental soil disturbance of 50 acres assumed would be harvested in the project area.
3/ Assumes 4 miles of roads and 3 percent soil disturbance as a result of 635 acres of harvest and on State lands.

4/ Sums may not add correctly due to rounding

### *Effects Common to All Alternatives*

See Table SOIL-1 for a summary of existing soil disturbances on the project area. Past timber harvest and road construction is associated with 302 landslides totaling about 449 acres. Natural soil disturbances and naturally occurring landslides would continue to occur under each alternative. Reasonably foreseeable projects with quantifiable effects are included in Table SOIL-6 above. The Roadside EA would contribute approximately 1.5 acres of detrimental soil disturbance. The remaining Control Lake sales would contribute approximately 16 acres of detrimental soil disturbance. Harvests on State lands would contribute approximately 38 acres of detrimental soil disturbance, which includes roads. As a result of harvest on State lands, landslides predicted from harvest on State lands would contribute approximately 3 acres over the next 30 years. Free Use Timber Sales would contribute approximately 0.3 acre of detrimental soil disturbance.

In addition, several reasonably foreseeable projects have effects common to all alternatives, but are not quantifiable at this stage, and are therefore not included in Table SOIL-6 above. Road activities on NFS lands include ongoing road maintenance on NFS roads will result in some soil disturbance; however, these do not count toward detrimental soil disturbance. Normally this type of work is determined to fit the category of routine repair and maintenance of roads that do not individually or cumulatively have a significant effect on the quality of the human environment and may be categorically excluded (FSH 1909.15, 321.12). Restoration activities could result in temporary, localized soil effects, but it is expected that the overall effect from activities, such as landslide and stream stabilization, would be beneficial to the soil resource. Recreation and facility projects in the project area would result in some additional soil disturbances; however, these effects would be limited by BMP implementation and do not count towards detrimental soil disturbance.

The following sections describe the cumulative effects by alternative.

### *Alternative 1*

In addition to the effects described for all alternatives above, the Big Thorne Project would not contribute to the cumulative detrimental soil disturbance. The reasonably foreseeable projects identified in Table SOIL-6 would result in about 60 acres of detrimental soil conditions. Total detrimental soil disturbance within the project area would be about 3,570 acres, or about 1.5 percent of the project area. Natural soil disturbances including landslides will continue to occur. Natural surface erosion due to ice, wind, water, or gravity that usually occurs in small patches will continue across the project area. Vegetation in harvested areas will continue to grow and add root mass and stability to the soil, thus landslide frequency will likely decline over time in the previously harvested areas (Landwehr 1994).

### *Alternative 2*

In addition to the effects described for all alternatives above, the implementation of Alternative 2 would contribute about 281 acres of detrimental soil disturbance. When combined with the reasonably foreseeable projects, detrimental soil disturbance on the project area would increase to approximately 3,851 acres, or about 1.7 percent of the project area (Table SOIL-6). This level of disturbance is well within Region 10 Soil Quality Standards at the project scale. Natural soil disturbances including landslides will continue to occur. After 30 years, about 477 cumulative acres of management-related landslides would have occurred in the project area (Tables SOIL-1, SOIL-4, and SOIL-6). Natural surface erosion due to ice, wind, water, or gravity that usually occurs in small patches will continue across the project area. Vegetation in previously harvested areas will continue to grow and add root mass and stability to the soil, thus landslide frequency will likely decline over time in the harvested areas (Landwehr 1994). Alternative 2 meets the Region 10 soil productivity standard in all units.

#### *Alternative 3*

In addition to the effects described for all alternatives above, the implementation of Alternative 3 would result in about 458 acres of detrimental soil conditions. When combined with the existing condition and reasonably foreseeable activities, detrimental soil disturbance on the project area would increase to approximately 4,028 acres, or about 1.7 percent of the project area (Table SOIL-6). This level of disturbance is well within Region 10 Soil Quality Standards at the project scale. Natural soil disturbances including landslides will continue to occur. After 30 years, about 498 cumulative acres of management-related landslides would have occurred in the project area (Tables SOIL-1, SOIL-4, and SOIL-6). Natural surface erosion due to ice, wind, water, or gravity that usually occurs in small patches will continue across the project area. Vegetation in previously harvested areas will continue to grow and add root mass and stability to the soil, thus landslide frequency will likely decline over time in the harvested areas (Landwehr 1994). All harvest units would meet Region 10 Soil Quality Standards at the unit scale, contingent on implementing the recommendations from the field review for young-growth areas.

#### *Alternative 4*

In addition to the effects described for all alternatives above, the implementation of Alternative 4 would include about 214 acres of detrimental soil conditions. When combined with the existing condition and reasonably foreseeable activities, detrimental soil disturbance on the project area would increase to approximately 3,784 acres, or about 1.6 percent of the project area (Table SOIL-6). This level of disturbance is well within Region 10 Soil Quality Standards at the project scale. Natural soil disturbances including landslides will continue to occur. After 30 years, about 485 cumulative acres of management-related landslides would have occurred in the project area (Tables SOIL-1, SOIL-4, and SOIL-6). Natural surface erosion due to ice, wind, water, or gravity that usually occurs in small patches will continue across the project area. Vegetation in previously harvested areas will continue to grow and add root mass and stability to the soil, thus landslide frequency will likely decline over time in the harvested areas (Landwehr 1994). All harvest units would meet Region 10 Soil Quality Standards at the unit scale.

#### *Alternative 5*

In addition to the effects described for all alternatives above, the implementation of Alternative 5 would include about 265 acres of detrimental soil conditions. When combined with the existing condition and reasonably foreseeable activities, detrimental soil disturbance on the project area would increase to approximately 3,835 acres, or about 1.7 percent of the project area (Table SOIL-6). This level of disturbance is well within Region 10 Soil Quality Standards at the project scale. Natural soil disturbances including landslides would continue to occur. After 30 years, about 488 cumulative acres of management-related landslides would have occurred in the project area (Tables SOIL-1, SOIL-4, and SOIL-6). Natural surface erosion due to ice, wind, water, or gravity that usually occurs in small patches will continue across the project area. Vegetation in previously harvested areas would continue to grow and add root mass and stability to the soil, thus landslide frequency would likely decline over time in the harvested areas (Landwehr 1994). All harvest units would meet Region 10 Soil Quality Standards at the unit scale.

# Climate Change

## Introduction

### Forest Plan Analysis

The EIS prepared for the 2008 Tongass Forest Plan Amendment discusses several issues related to climate change. These include the considerable uncertainty concerning specific predictions of how the climate may change, and the uncertainty regarding the effects of climate change on the resources of the Tongass. To deal with this uncertainty, the Tongass National Forest will continue to monitor potential effects of climate change through the existing Forest Plan monitoring programs, and other studies that are happening regionally and nationally.

The 2008 Forest Plan EIS contains an extensive discussion of climate change related to management activities (pgs. 3-11 to 3-20, 3-50 to 3-51, 3-77, 3-92 to 3-93, 3-116 to 3-117, 3-125 to 3-126, 3-203, 3-250, 3-296, 3-340, 3-351, 3-401). Models available for estimating climate change are designed to predict changes on a regional scale and are not detailed enough to predict changes to the Tongass National Forest specifically. Existing models do not entirely agree on how global warming will affect Southeast Alaska. The variation and possibilities are discussed extensively in the 2008 Forest Plan Amendment EIS. Further discussion on climate change issues and vegetation can be found in the Climate Change and other resource reports (Crookston 2012; Barnhart and Iozzi 2012).

The 2008 ROD for the Tongass Plan Amendment concludes that because of the uncertainty related to the specific effects of climate change on the resources of the Tongass, the uncertainty about how activities on the Forest affect climate change and the predicted small magnitude of these effects, the best course of action is continued management of the Tongass for resiliency in ecosystem functions. This will be accomplished primarily by management of the Tongass as a mostly intact ecosystem with a robust monitoring plan that will allow for adaptive management intervention if and when effects of climate change are more certain. Important components of the 2008 Tongass Forest Plan include:

§ A conservation strategy that includes an extensive reserve system in non-development land use designations and standards and guidelines where active management is minimized that protect over 90 percent of the existing productive old-growth habitat.

§ Standards and guidelines that include specific protection measures for soils on slopes that are >67 percent and >72 percent. These measures help retain carbon stored as organic material in soils where timber harvest and road building occur.

In addition to the Forest Plan's monitoring and evaluation provisions that address the effects of climate change, there are Regional forest health program monitoring changes related to insects, disease, pathogens, windthrow, and the long-term forest inventory system. If these efforts detect changes due to climate, they will be addressed through existing planning procedures to determine whether changes in management are warranted.

Even at the Forest Plan level, differences between alternatives in terms of the effects of climate change on the Tongass—and in the effects of land management activities on climate change—are uncertain, unquantifiable, and likely to be small (especially when compared to other routine human activities). For these reasons, information on climate change was deemed not essential to a reasoned choice among the alternatives considered in the 2008 Forest Plan EIS, and therefore for these same reasons, would not be essential to a reasoned choice among alternatives for the Big Thorne EIS (Kimbell 2009).

The Tongass National Forest is currently adjusting management in relation to climate change. Based on ongoing research and scientific recommendations (Hennon et al. 2007), and in response to the public's concern about cedar decline, the regeneration of yellow-cedar is being more closely monitored and efforts made to influence species composition to include more Alaska yellow-cedar in regenerating stands. This will allow managers the ability to maintain or increase yellow-cedar on sites judged to be suitable for the species long-term survival (i.e., not prone to future yellow-cedar decline due to climate change) using future intermediate treatments such as PCT.

The Tongass held a workshop in the spring of 2012 with key stakeholders, relevant scientists and other agency personnel, business/community leaders, and internal personnel to identify key resources at risk and to set priorities for a climate vulnerability assessment. Information gathered through this workshop does not suggest that climate change is currently producing strong negative effects for most resources on the Tongass. Based on the current understanding of climate change in southeast Alaska and action alternatives associated with the Big Thorne Project, specific adaptation actions are not necessary to meet Forest Plan objectives at this time.

The Tongass National Forest is collaborating with EcoAdapt to produce a concise assessment of climate vulnerability addressing topics related to management decisions faced by the Tongass. These first two assessments are scheduled to be completed in 2013 and will address the topics of ice, snow, and fisheries. Additional topics will be addressed as collaborations are developed and topics become ripe for assessment.

## *Environmental Consequences*

The overall carbon mass stored in aboveground trees, snags and logs in the Tongass National Forest is huge. A rough estimate based on FIA data and extrapolating to include uninventoried wilderness areas is about 650 million tons in aboveground tree carbon or the equivalent of 2.4 billion tons of $CO_2$ (Barrett [n.d.]).

Harvesting of old growth creates an initial net release of $CO_2$ into the atmosphere relative to the baseline (no action), which can continue for years as logs and snags left after harvest decompose (Harmon et al. 1990).

At some point in the future, the managed young-growth stand(s) that follow harvest via the action alternatives could result in greater net sequestration of carbon than the No-action Alternative, but the relatively slow growth rates of most stands on the Tongass and the relatively high amount of dead wood left after harvest would reduce this potential. Additionally, while there is a substantial amount of recent literature about the effects of forest management on carbon stores, different authors have reached widely varied conclusions about net sequestration because of varied assumptions about the time frame of interest, initial volume, post-harvest residuals, decay rates, the amount of energy expended in harvest and transport, utilization rates, life-span of wood products, future growth rates of second-growth stands, temporal discounting, and substitution effects (e.g., Barrett [n.d.], and Malmsheimer et al 2011

Annual flux and turnover rates in live tree and snag carbon pools based on re-measured data have recently been estimated for the Tongass. Overall, live trees in the Tongass National Forest remove about -2,787 pounds of $CO_2$ per acre per year through growth and recruitment, which is largely (estimated 90 percent) balanced by $CO_2$ returning to the atmosphere from mortality and harvest, assuming eventual decay of those trees (Barrett [n.d.]).

## Direct, Indirect and Cumulative Effects

### *Alternative 1 (No Action)*

Alternative 1 is the No-Action Alternative. In addition to being an alternative to the proposed action, it provides a baseline for evaluation of the impacts associated with the action alternatives. It would result in no timber harvest or road construction activities within the project area, so there would be no management-related activities contributing to climate change effects.

### *Alternatives 2, 3, 4, and 5*

At the project level, perhaps the best indicator of the effects to climate change can be equated to the amount of timber harvested and/or road constructed.

Carbon sequestration, the flow of carbon into aquatic or terrestrial systems from the atmosphere, is difficult to evaluate. Mature forests in Alaska are considered to be carbon "sinks," meaning that these forest stands accumulate more carbon than they release (Forest Plan pg. 3-17). The regeneration of trees that follow timber harvest has rapid growth relative to old growth, which also accumulates carbon into the system.

When considering the varying degrees of forest site conditions, the lifecycle of wood products, and the substitution effect of using wood products over other materials, the point of equilibrium in the loss or gain of carbon following old-growth harvest is subject to much uncertainty. However, for the purpose of this analysis, it is assumed that in the short term, that "harvesting forests with high biomass and planting new forest reduces overall C stocks more in the near term than if the forest were retained, even counting the C storage in harvested wood products" (Vos et al. 2012)

The action alternatives propose varying levels of timber harvest and road construction, and would result in an initial net release of $CO_2$ into the atmosphere above that of No Action. Alternative 3 proposes the most harvest (indicating it would have the largest effect on carbon sequestering) followed by Alternatives 5, 2, and 4. Alternative 3 also proposes the most road construction (further indicating it would have the largest effect on Carbon Sequestering) followed by Alternatives 4, 2, and 5.

It is estimated that the forests of the Tongass represent approximately only one quarter of 1 percent of the stored carbon in forests worldwide (Forest Plan 3-19). Within the Big

Thorne project area, this percentage is considerably smaller. Carbon stored in forests, including forest soils, represent a small portion of total global carbon storage (terrestrial, ocean, atmospheric, and fossil carbon pools); for example, the oceans store approximately 20 times as much carbon as all terrestrial systems (IOC 2007). Therefore, it is reasonable to conclude that small, if even measurable, changes in carbon sequestration under any of the action alternatives, whether positive or negative, would not be a relevant factor for choosing among alternatives. Additionally, as described above and in the Forest Plan, the task of understanding all the factors that influence climate change and how carbon is sequestered contains substantial uncertainty and for these reasons is not essential to a reasoned choice among alternatives.

None of the action alternatives are predicted to measurably contribute to the cumulative effects on climate change.

## BIOLOGICAL ENVIRONMENT

# *Fisheries*

## *Introduction*

Streams and lakes of the Big Thorne project area provide important habitat for the production of resident and anadromous fish resources. These resources support the Prince of Wales subsistence, sport, guided (both freshwater and saltwater), and commercial fisheries of the area as well as traditional and cultural values. Fish are a major component of the biodiversity of Southeast Alaska. The annual migrations of anadromous fish for spawning are necessary for the functioning of many plant and animal communities. Willson and Halupka (1995), in their discussion of anadromous fish as keystone species, list 36 birds and mammals that consume salmon or salmon eggs in Southeast Alaska. Animals such as the black bear and bald eagle depend on salmon as a primary food source. Abundant rainfall and watersheds with high stream densities provide an unusual number and diversity of freshwater habitats. These abundant freshwater systems on the Tongass National Forest provide spawning and rearing habitat for most of the fish produced in Southeast Alaska.

Watershed and subwatershed boundaries and names for the Big Thorne project area are based on Forest Service 5th, 6th, 7th level watershed dataset. Often all three levels have been characterized as "watersheds" for analysis of varied project effects on Prince of Wales Island. However, for the Big Thorne Project, watersheds and subwatersheds have been analyzed separately for Issue 4 – Cumulative Watershed Effects (earlier in this chapter) and in the Watershed Resource Report (James 2013). The subsections below use the same definitions described for watersheds and subwatersheds in Issue 4. However, most of the discussions on effects to fisheries resources are limited to the breakdown at the subwatershed level, which provides a finer-scale division for descriptions of baseline conditions and potential project effects.

### Stream Type Definitions

Stream classification and channel type characteristics are the primary factors used in determining potential production of fish within the Tongass as well as types of protection needed relative to forest management actions. The Tongass National Forest uses two specific categorization systems to describe streams. The first is broadly defined as a stream value classification and defines relative fish use or presence in streams; it is called Stream Class, or Aquatic Habitat Management Unit (AHMU) class. The second is a classification of streams into Process Groups and Channel Types. These are based on stream geomorphic characteristics and location within the watershed, which is important for assessing fish habitat capability and sensitivity to management actions.

The Alaska Region stream value classification (stream class) is based on subsistence, recreational, and economic fish harvest considerations. The value classes do not imply either ecological importance or prioritization of fish harvest over maintenance of watershed function. Stream classes are as follows:

1. Class I. Streams and lakes with anadromous (migrating from the ocean) or

adfluvial (migrating from lakes) fish or fish habitat; or, high-quality resident fish waters, or habitat above fish migration barriers known to provide reasonable enhancement opportunities for anadromous fish.

2. Class II. Streams and lakes with resident fish or fish habitat and generally steep (6 to 25 percent or higher) gradients where no anadromous fish occur, and otherwise not meeting Class I criteria.
3. Class III. Streams are perennial and intermittent streams that have no fish populations or fish habitat, but have sufficient flow or sediment and debris transport to directly influence downstream water quality or fish habitat capability.
4. Class IV. Other intermittent, ephemeral, and small perennial channels with insufficient flow or sediment transport capabilities to directly influence downstream water quality or fish habitat capability. These streams have bankfull width of at least 1 foot over the majority of the stream segment. Class IV streams are too small to be mapped on aerial photographs, thus only the ones field verified are listed.

Process groups describe the geomorphic properties of stream channels and their general location in the landscape, while channel types further differentiate channels within process groups. AHMU class, channel types and process groups are used to assign appropriate buffers. Methods of determining channel type and process group are in FSH 2090.21 (USDA 2001). The process group code is explained below in Table FISH-1.

### Methodology

Methodology used for fish habitat assessment included both GIS analysis and field surveys. GIS analysis included initial determination of stream characteristics (class, type, length, location), existing and proposed road locations and distance, and road-stream crossing information within the proposed project area. Many of these parameters were field verified. The interdisciplinary team used channel type and stream class data, anadromous and resident fish stream road condition surveys (RCS) data, ADF&G stream catalog, and field survey results in the vicinity of proposed activities, as a basis for effects analysis.

The effects of the alternatives were compared using quantitative variables such as number of existing stream crossings and proposed stream crossings, miles and area of existing and proposed road constructed, acres of past riparian management area harvested, miles of existing roads in riparian management areas (RMA), acres of past and proposed harvest and percent canopy removed. These same parameters were considered in a cumulative manner for other reasonably foreseeable project area actions.

See the Fisheries Resource Report (Knutzen 2013) for more information on methods used.

**Table FISH-1.** Brief Description of Process Groups

| Process Group | Process Group Name | Channel Morphometry | Channel Sediment Function | Fish Habitat |
|---|---|---|---|---|
| HC | High Gradient Contained | Steep mountain slope tributaries | Source and transport channel system | Small resident fish populations and limited anadromous fish-rearing habitat |
| AF | Alluvial Fan | Multi-branched channels on depositional footslopes | Episodic deposition processes | Low productivity due to dynamic channels and interrupted surface flow |
| MM | Moderate Gradient Mixed Control | Valley bottom streams with variable confinement | Transitional transport/deposition channels influence by bedrock control and riparian vegetation. | Moderate to Highly Productive anadromous and resident spawning and fish-rearing habitat |
| MC | Moderate Gradient Contained | Completely contained by adjacent landforms frequently by bedrock | Efficient sediment transport and delivery channels | Low to moderate productive anadromous and resident fish-rearing and spawning habitat |
| LC | Low Gradient Contained | Moderately incised and well contained low gradient streams in lowlands and large valleys | Mixed sediment storage and transport channels | Moderately productive resident and anadromous fish-rearing and spawning habitats |
| FP | Flood Plain | Unconfined valley flood plain streams | Complex depositional channel networks | Diverse and Highly productive anadromous fish-spawning and -rearing habitat |
| PA | Palustrine | Low gradient streams associated with low relief landforms and wetland drainage networks | Peatland-bog runoff dominates | Highly productive juvenile anadromous and resident fish-rearing potential |
| ES | Estuarine | Intertidal streams influenced by tidal inundation | Primarily depositional environments including saltwater marshes, mudflats and gravel deltas | Low to high productivity anadromous and resident fish-rearing and -spawning habitat, varying by specific channel type |

Source: Paustian et al. 1992; Paustian and Kelliher 2010

## *Affected Environment*

This section describes the affected environment and existing condition in the subwatersheds where activities are proposed. Table WTR-2 under Issue 4 lists subwatershed acres.

Alaska Department of Fish and Game (ADF&G) developed a rating system to rank VCUs on the Tongass National Forest which classified VCUs as Primary Fish Producers if they were in the top 10 percent of all VCUs in Southeast Alaska for pink salmon escapement, potential coho salmon smolt production, or angler effort or if it had a close connection (e.g., same river system) to another VCU that was ranked as a Primary Fish Producer (Flanders et al. 1998). Within the project area, eight VCUs (5750, 5760, 5780, 5860, 5950, 5960, 5971, and 5972), which included parts of several subwatersheds in the project area including Thorne Lake, Control Lake (two VCUs), Snakey Lakes Lowlands, around Thorne Bay (parts of seven subwatersheds), North Big Salt, Central Thorne River, and Goose Creek/Rio Beaver subwatersheds were rated as Primary Fish Producers (Figure WTR-2). ADF&G recommends that those VCUs that have the highest resource value should be managed to reduce risks to fish and wildlife and their habitats.

## Stream and Lake Habitat

The Big Thorne project area has about 1,500 miles of streams and over 3,100 acres of lakes and ponds. Streams are differentiated by process group, channel type and by AHMU class (Tables FISH-2 through FISH-4).

Each process group varies in the amount and quality of fish habitat. Some process groups provide more rearing habitat for juveniles and some have more spawning habitat for adult fish. The amount of habitat that is available is directly based on the miles of each process group in a given subwatershed. Table FISH-2 shows the miles of stream for each process group for each subwatershed. About 61 percent of the stream miles are in the HC process group and about 24 percent of the stream miles are in the more productive and sensitive process groups (ES, FP, PA, and MM).

Stream classes provide a means to categorize stream channels based on their fish production values. Stream Classes I and II receive more protection because they have fish populations. Table FISH-3 shows the total length of stream (in miles) for each stream class in each subwatershed. The length of Class I and II streams (fish-bearing stream classes) for each subwatershed will give an indication of which subwatersheds have more fish habitat and greater risk of impacts from management activities. Over the project area subwatersheds, nearly half (45 percent) of the known stream miles are fish-bearing streams (Class I and II), although it is acknowledged that Class IV streams are greatly underrepresented in the overall GIS data base. Lakes play an important role in water storage, as sediment and organic matter sinks and as moderator of highs and lows in downstream water quality conditions, especially for larger lakes. They are also important sources of fish habitat, especially for juvenile sockeye salmon and resident Dolly Varden and cutthroat trout. Lakes provide needed over-wintering habitat for coho and sockeye salmon, steelhead trout, resident Dolly Varden, and cutthroat trout, with over 92 percent of all project area lakes Class I or II (Table FISH-4). Five subwatersheds account for over 65 percent of the lake area in the project area; these include Big Ratz, Control Lake, Eagle Creek, Goose Creek, and Thorne Lake (Table FISH-4). The largest lake in the project area is Luck Lake in the Eagle Creek watershed. These subwatersheds all exceed 300 acres of lake habitat, while the remaining have less than 300 acres each. No data on lake depths, volumes, or water quality are available.

**Table FISH-2.** Stream Miles by Process Group by Subwatershed

| Subwatershed | Miles of Stream by Process Group[1/] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | HC | MM | FP | PA | MC | AF | LC | ES | UC [2/] | UI [3/] | Total [2/] |
| Baird Peak | 17.5 | 0.8 | 0 | 0.5 | 0.6 | 1.9 | 0 | 0.1 | 2.2 | 0.5 | 23.9 |
| Barren | 4.6 | 5.5 | 0 | 0.5 | 0.1 | 0 | 0 | 0.0 | 1.1 | 0.2 | 12.0 |
| Big Ratz | 48.5 | 6.4 | 1.7 | 2.7 | 3.9 | 2.7 | | 0 | 5.1 | 0 | 71.0 |
| Central Thorne River | 5.6 | 6.4 | 9.2 | 14.0 | 3.4 | 0.2 | 0.0 | 0.0 | 2.2 | 0 | 41.0 |
| Cobble Creek | 10.4 | 2.3 | 0.5 | 0.1 | 1.1 | 0 | 0 | 0 | 0.8 | 0.2 | 15.4 |
| Control Lake | 75.9 | 15.0 | 6.0 | 8.9 | 13.9 | 2.1 | 5.1 | 0 | 1.0 | 0 | 127.9 |
| Deer Creek | 11.6 | 4.3 | 0 | 4.1 | 0.5 | 0 | 0 | 0 | 1.9 | 0.2 | 22.5 |
| Doughnut | 6.9 | 1.5 | 0 | 0.2 | 1.4 | 0 | 0 | 0 | 0.1 | 0.7 | 10.9 |
| Eagle Creek/Slide Creek | 20.9 | 5.4 | 2.4 | 0.2 | 0 | 3.7 | 0.1 | 0 | 0.9 | 0 | 33.6 |
| East Fork North Thorne | 50.1 | 5.0 | 5.0 | 3.8 | 0.3 | 5.6 | 0 | 0 | 5.1 | 0 | 74.9 |
| Falls Creek | 15.5 | 1.1 | 0 | 0.6 | 0.5 | 0.3 | 0.2 | 0 | 0.3 | 0 | 18.5 |
| Goose Creek | 57.2 | 12.3 | 6.0 | 7.5 | 6.7 | 2.6 | 2.9 | 0 | 4.9 | 0 | 100.2 |
| Gravelly Creek | 37.7 | 3.8 | 5.0 | 2.2 | 2.6 | 0.8 | 0.3 | 0 | 3.2 | 0.1 | 55.7 |
| Lake Ellen | 15.5 | 6.4 | 0.6 | 2.9 | 3.4 | 2.0 | 0 | 0.5 | 0 | 1.1 | 32.5 |
| Little Ratz Creek | 18.5 | 4.3 | 1.5 | 0.6 | 0.7 | 1.1 | 0 | 0.3 | 2.8 | 0 | 29.7 |
| Luck Lake | 36.8 | 6.2 | 0.6 | 2.1 | 0.8 | 2.9 | 0 | 0.2 | 7.7 | 0 | 57.3 |
| Luck Point | 5.3 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 7.2 |
| No Name | 12.6 | 0.8 | 0 | 0.2 | 0.2 | 0.1 | 0 | 0 | 1.5 | 0.0 | 15.4 |
| North | 8.2 | 1.8 | 0.6 | 0.1 | 0.9 | 0 | | 0.1 | 1.2 | 1.7 | 14.6 |
| North Big Salt Lake | 140.5 | 13.1 | 13.0 | 4.3 | 16.4 | 1.2 | 0.5 | 0.2 | 3.8 | 0 | 193.0 |
| North Kasaan Bay Frontage | 21.1 | 4.8 | 0.4 | 1.2 | 1.7 | 1.1 | 0 | 0.3 | 0 | 3.5 | 34.1 |
| North Sal | 4.6 | 0.5 | 0 | 0 | 0 | 0.1 | 0 | 0.0 | 0.9 | 0.4 | 6.4 |
| Pin | 5.4 | 0.2 | 0.4 | 0.1 | 0.8 | 0 | 0 | 0 | 0.2 | 0.1 | 7.3 |
| Ratz Harbor | 1.7 | 0.7 | 0 | 0.8 | 0 | 0 | 0 | 0.1 | 0.4 | 0.3 | 3.9 |
| Rio Beaver Creek | 52.4 | 5.8 | 9.2 | 3.0 | 2.0 | 3.1 | 1.8 | 0 | 1.3 | 0 | 78.6 |
| Sal Creek | 29.5 | 2.8 | 2.2 | 0.9 | 1.6 | 2.6 | 0 | 0.3 | 0.9 | 0 | 40.8 |
| Salamander | 5.5 | 2.9 | 0 | 0.1 | 0 | 0.3 | 0 | 0 | 0.5 | 0.1 | 9.3 |
| Slide Creek | 20.5 | 8.2 | 2.7 | 1.9 | 2.1 | 0.4 | 0.4 | 0.1 | 0.4 | 0.2 | 36.9 |
| Snakey Lakes Lowlands | 5.9 | 6.4 | 3.9 | 15.4 | 2.2 | 0 | 3.2 | 0 | 1.2 | 0 | 38.1 |
| Thorne | 10.7 | 1.7 | 0.4 | 0.7 | 0.3 | 0 | 0 | 0.1 | 0.6 | 0.6 | 15.0 |
| Thorne Bay | 25.0 | 8.1 | 0.2 | 2.9 | 2.0 | 0.2 | 0 | 0.4 | 0 | 2.1 | 40.9 |
| Thorne Lake | 52.4 | 9.8 | 9.0 | 13.0 | 7.5 | 1.7 | 2.8 | 0 | 1.5 | 0 | 97.9 |
| Thorne River Intertidal | 4.4 | 1.0 | 0 | 0.9 | 1.0 | 0.1 | 0 | 3.4 | 0.6 | 2.0 | 13.2 |
| Tiny | 3.3 | 0.2 | 0 | 0.2 | 0.4 | 0 | 0 | 0 | 0.1 | 0.2 | 4.4 |
| Torrent | 5.5 | 1.5 | 0.2 | 0.2 | 1.1 | 0 | 0 | 0.9 | 0.3 | 0.5 | 10.1 |
| West Fork Luck Creek | 34.7 | 2.8 | 5.3 | 1.5 | 0 | 2.1 | 0.4 | 0 | 5.9 | 0 | 52.9 |
| West Fork North Thorne | 55.6 | 6.1 | 7.5 | 3.4 | 0.2 | 4.0 | 0 | 0 | 7.5 | 0 | 84.2 |
| **Total** | 937.8 | 166.8 | 93.6 | 101.7 | 80.2 | 42.6 | 17.7 | 6.9 | 68.7 | 15.3 | 1531.3 |

1/ Process group code definitions can be found in Table Fish-1 and the unit cards (Appendix B).
2/ UC= Unclassified streams
3/ UI= Unidentified intertidal channels

**Table FISH-3.** Known Stream Miles by AHMU Class and Basin Area by Subwatershed

| Watershed | Basin Area (Sq. Mi.) | Miles of Stream by Class[1/] | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | Total |
| Baird Peak | 6.6 | 1.1 | 5.3 | 12.1 | 5.4 | 23.9 |
| Barren | 3.1 | 4.7 | 2.6 | 2.1 | 2.7 | 12.0 |
| Big Ratz | 16.1 | 10.1 | 19.3 | 27.1 | 14.5 | 71.0 |
| Central Thorne River | 10.9 | 30.9 | 4.4 | 1.9 | 3.9 | 41.0 |
| Cobble Creek | 3.3 | 4.2 | 1.2 | 7.6 | 2.4 | 15.4 |
| Control Lake | 29.1 | 44.9 | 18.1 | 63.2 | 1.7 | 127.9 |
| Deer Creek | 4.5 | 0.8 | 13.0 | 3.9 | 4.8 | 22.5 |
| Doughnut | 2.9 | 3.4 | 5.1 | 2.4 | 0.1 | 10.9 |
| Eagle Creek/Slide Creek | 7.1 | 10.8 | 4.1 | 12.8 | 6.0 | 33.6 |
| East Fork North Thorne | 11.8 | 18.9 | 3.8 | 39.5 | 12.6 | 74.9 |
| Falls Creek | 3.8 | 2.6 | 6.2 | 8.0 | 1.6 | 18.5 |
| Goose Creek | 21.1 | 34.9 | 9.6 | 30.1 | 25.7 | 100.2 |
| Gravelly Creek | 10.7 | 13.9 | 7.8 | 25.7 | 8.3 | 55.7 |
| Lake Ellen | 8.3 | 17.0 | 3.6 | 12.0 | 0.0 | 32.5 |
| Little Ratz Creek | 5.5 | 3.1 | 7.0 | 13.2 | 6.4 | 29.7 |
| Luck Lake | 11.7 | 11.0 | 8.7 | 19.7 | 17.9 | 57.3 |
| Luck Point | 2.2 | 1.9 | 2.1 | 1.0 | 2.2 | 7.2 |
| No Name | 2.4 | 0.0 | 3.4 | 9.5 | 2.4 | 15.4 |
| North | 3.2 | 5.7 | 2.0 | 3.6 | 3.3 | 14.6 |
| North Big Salt Lake | 31.7 | 24.7 | 45.7 | 98.2 | 24.3 | 193.0 |
| North Kasaan Bay Frontage | 23.0 | 10.9 | 6.2 | 17.0 | 0.0 | 34.1 |
| North Sal | 1.1 | 0.6 | 0.2 | 2.6 | 3.1 | 6.4 |
| Pin | 1.3 | 2.3 | 3.4 | 1.3 | 0.3 | 7.3 |
| Ratz Harbor | 1.3 | 1.1 | 1.9 | 0.1 | 0.8 | 3.9 |
| Rio Beaver Creek | 14.1 | 23.7 | 9.2 | 29.6 | 16.2 | 78.6 |
| Sal Creek | 7.3 | 7.5 | 4.9 | 25.3 | 3.2 | 40.8 |
| Salamander | 2.0 | 3.4 | 3.1 | 2.0 | 0.9 | 9.3 |
| Slide Creek | 10.1 | 8.5 | 12.9 | 14.5 | 0.8 | 36.9 |
| Snakey Lakes Lowlands | 10.4 | 30.3 | 1.9 | 4.0 | 1.9 | 38.1 |
| Thorne | 3.9 | 4.6 | 3.5 | 5.1 | 1.8 | 15.0 |
| Thorne Bay | 9.9 | 16.8 | 9.2 | 14.8 | 0.0 | 40.9 |
| Thorne Lake | 25.2 | 37.7 | 14.9 | 41.7 | 3.5 | 97.9 |
| Thorne River Intertidal | 2.8 | 9.0 | 1.0 | 1.1 | 2.1 | 13.2 |
| Tiny | 0.8 | 0.2 | 0.6 | 2.5 | 1.1 | 4.4 |
| Torrent | 2.8 | 2.5 | 2.6 | 3.8 | 1.3 | 10.1 |
| West Fork Luck Creek | 11.4 | 11.8 | 3.7 | 26.7 | 10.7 | 52.9 |
| West Fork North Thorne | 13.1 | 17.5 | 11.0 | 31.8 | 23.8 | 84.2 |
| **Total** | 336.9 | 433.2 | 263.0 | 617.4 | 217.7 | 1531.3 |

1/ Class IV streams greatly under represented as streams can only be determined by site surveys.

**Table FISH-4.** Lake Area by AHMU Class in the Project Area Subwatersheds

| Subwatershed | Total Subwatershed Lake Acres | Percent of Lake Acres in Project Area[1/] | Project Area Lake Acre by Lake Class | | | | Total Lake Acres in Project Area |
|---|---|---|---|---|---|---|---|
| | | | Landlocked[2/] | Class I | Class II | Class III | |
| Baird Peek | 70.3 | 100 | 2.2 | 0.0 | 0.0 | 68.1 | 70.3 |
| Barren | 0.0 | NA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Big Ratz | 324.0 | 100 | 1.7 | 259.2 | 63.1 | 0.0 | 324.0 |
| Central Thorne River | 52.6 | 100 | 0.9 | 51.6 | 0.0 | 0.0 | 52.6 |
| Cobble Creek | 1.5 | 100 | 0.0 | 0.0 | 0.0 | 1.5 | 1.5 |
| Control Lake | 407.5 | 100 | 11.4 | 385.3 | 0.9 | 9.9 | 407.5 |
| Deer Creek | 34.2 | 100 | 0.3 | 0.0 | 26.3 | 7.6 | 34.2 |
| Doughnut | 12.1 | 100 | 0.2 | 2.0 | 9.9 | 0.0 | 12.1 |
| Eagle Creek/Slide Creek | 1.2 | 100 | 0.0 | 1.2 | 0.0 | 0.0 | 1.2 |
| East Fork North Thorne | 9.1 | 100 | 1.9 | 7.2 | 0.0 | 0.0 | 9.1 |
| Falls Creek | 18.0 | 100 | 2.4 | 15.7 | 0.0 | 0.0 | 18.0 |
| Goose Creek | 359.6 | 87 | 10.2 | 284.6 | 17.2 | 2.4 | 314.3 |
| Gravelly Creek | 11.6 | 100 | 1.6 | 0.0 | 0.0 | 10.0 | 11.6 |
| Lake Ellen | 115.4 | 4 | 0.0 | 0.0 | 0.0 | 4.8 | 4.8 |
| Little Ratz Creek | 5.8 | 100 | 0.3 | 0.0 | 0.0 | 5.5 | 5.8 |
| Luck Lake | 529.4 | 100 | 3.2 | 516.5 | 0.0 | 9.1 | 528.9 |
| Luck Point | 4.3 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| No Name | 2.4 | 100 | 0.0 | 0.0 | 0.0 | 2.4 | 2.4 |
| North | 0.0 | NA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| North Big Salt Lake | 21.7 | 100 | 12.1 | 1.1 | 8.5 | 0.0 | 21.7 |
| North Kasaan Bay Frontage | 72.8 | 6 | 0.0 | 2.2 | 0.0 | 2.2 | 4.4 |
| North Sal | 0.0 | NA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pin | 38.5 | 100 | 2.4 | 36.2 | 0.0 | 0.0 | 38.5 |
| Ratz Harbor | 0.0 | NA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rio Beaver Creek | 8.3 | 100 | 3.8 | 4.5 | 0.0 | 0.0 | 8.3 |
| Sal Creek | 2.6 | 100 | 0.0 | 0.0 | 0.0 | 2.6 | 2.6 |
| Salamander | 66.2 | 100 | 0.0 | 66.2 | 0.0 | 0.0 | 66.2 |
| Slide Creek | 74.8 | 100 | 2.6 | 46.6 | 23.3 | 2.3 | 74.8 |
| Snakey Lakes Lowlands | 263.4 | 100 | 4.2 | 259.2 | 0.0 | 0.0 | 263.4 |
| Thorne | 42.2 | 100 | 0.6 | 41.6 | 0.0 | 0.0 | 42.2 |
| Thorne Bay | 261.3 | 100 | 5.6 | 252.1 | 0.0 | 3.0 | 260.7 |
| Thorne Lake | 517.8 | 97 | 11.0 | 485.4 | 0.5 | 6.6 | 503.5 |
| Thorne River Intertidal | 22.8 | 98 | 0.8 | 21.5 | 0.0 | 0.0 | 22.3 |
| Tiny | 0.0 | NA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Torrent | 4.2 | 100 | 4.2 | 0.0 | 0.0 | 0.0 | 4.2 |
| West Fork Luck Creek | 7.6 | 88 | 3.6 | 0.0 | 0.0 | 3.1 | 6.7 |
| West Fork North Thorne | 3.5 | 100 | 2.8 | 0.7 | 0.0 | 0.0 | 3.5 |
| **Total** | **3,351.9** | **93** | **90.0** | **2,740.7** | **149.7** | **141.0** | **3,121.4** |

1/ Percent values rounded

2/ Landlocked are lakes with no associated downslope exit drainage streams

## Fish Species in the Project Area

A total of seven anadromous and/or resident salmonid fish species are present in project area streams. The species include four of the five Pacific Coast salmon, one char, a trout species, and steelhead:

- Pink salmon (*Oncorhynchus gorbuscha*)
- Chum salmon (*O. keta*)
- Coho salmon (*O. kisutch*)
- Sockeye salmon (*O. nerka*)
- Steelhead (*O. mykiss*)
- Cutthroat trout (*O. clarki*)
- Dolly Varden char (*Salvelinus malma*)

The known presence of salmonid fish in project area subwatersheds is included in Table FISH-5. Detailed descriptions of habitat requirements at various life stages and important fish-bearing streams are described in the Fisheries Resource Report (Knutzen 2013).

## Management Indicator Species

NFMA regulations direct the use of MIS in Forest planning to help display the effects of forest management. MIS are species whose population changes are believed to indicate the effects of land management activities. The Tongass Forest Plan selected pink and coho salmon, Dolly Varden char, and cutthroat trout as MIS as representative of varied fish life history habitat uses of the Tongass stream systems. Details of species-specific habitat use are presented in the Fisheries Resource Report (Knutzen 2013).

## Threatened, Endangered, and Proposed Listed Fish or Sensitive Fish Species

Under Section 7 of the ESA, Federal agencies are required to ensure that actions are not likely to jeopardize the continued existence of a listed species. The effects analysis for threatened and endangered (T&E) species is required to address the direct and indirect effects of the action(s) on T&E species and their critical habitat (50 CFR 402.02). The effects analysis is to comply with Section 7 of the ESA which requires all Federal agencies, in consultation with the USFWS and NMFS, to ensure that their actions are not likely to jeopardize the continued existence of T&E species or adversely modify their habitat.

There are no fish species in the streams and lakes of the Tongass National Forest that are federally ESA listed or under the State of Alaska ESA. However, the listing of Pacific herring in Southeast Alaska as a candidate species for Federal listing results in this species being included as a sensitive species in Tongass National Forest. The Southeast Alaska Distinct Population Segment (DPS) of Pacific herring was listed as a Federal candidate species in 2008 (73 Federal Register 19824).

**Table FISH-5.** Known Anadromous and Resident Fish Species Presence by Subwatershed in the Project Affected Area

| Subwatershed | Anadromous Salmon, Char, and Trout [1/] | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Pink** | **Chum** | **Coho** | **Sockeye** | **Dolly Varden** | **Cutthroat** | **Steelhead** |
| Baird Peak | | | Y | | Y(r) | | |
| Barren | Y | | Y | | Y | | |
| Big Ratz | Y | Y | Y | Y | Y(a,r) | Y(r) | Y |
| Central Thorne River | Y | Y | Y | Y | Y(a,r) | Y(a,r) | Y |
| Cobble Creek | Y | Y | Y | | Y(a,r) | Y(a,r) | |
| Control Lake | Y | | Y | Y | Y(r) | Y(r) | Y |
| Deer Creek | Y | | | | Y(r) | Y(a,r) | Y(r) |
| Doughnut | Y | | Y | | | Y | |
| Eagle Creek/Slide Creek | Y | Y | Y | Y | Y(a,r) | Y(a,r) | Y |
| East Fork North Thorne | Y | | Y | Y | Y(a,r) | Y(a,r) | Y |
| Falls Creek | Y | Y | Y | | Y | Y | |
| Goose Creek | | | Y | Y | Y(a,r) | Y(a,r) | Y |
| Gravelly Creek | Y | Y | Y | | Y(a,r) | Y(r) | Y(a) |
| Lake Ellen | Y | Y | Y | | Y(a,r) | Y(a,r) | Y |
| Little Ratz Creek | Y | Y | Y | | Y(r) | Y(r) | Y |
| Luck Lake | Y | Y | Y | Y | Y(a,r) | Y(a,r) | Y |
| Luck Point | | | | | Y | Y | |
| No Name[2/] | | | | | | | |
| North | Y | Y | Y | | Y(r) | Y(r) | Y(r) |
| North Big Salt Lake | Y | Y | Y | | Y(a,r) | Y(a,r) | Y |
| North Kasaan Bay Frontage | | | | | Y(r) | Y(r) | |
| North Sal | | | | | Y(r) | | |
| Pin | Y | | Y | | Y | | |
| Ratz Harbor | Y | Y | Y | | Y(r) | Y(r) | |
| Rio Beaver Creek | Y | Y | Y | | Y(a,r) | Y(a,r) | Y |
| Sal Creek | Y | Y | Y | | Y(a,r) | Y(a,r) | Y |
| Salamander | Y | | Y | | Y(a,r) | Y(a,r) | |
| Slide Creek | Y | Y | Y | Y | Y(r) | Y(a,r) | |
| Snakey Lakes Lowlands | Y | | Y | Y | Y(a,r) | Y(a,r) | Y |
| Thorne Bay | Y | | Y | | Y(a,r) | Y(a,r) | |
| Thorne | Y | | Y | | | Y | |
| Thorne Lake | Y | Y | Y | Y | Y(r) | Y | Y |
| Thorne River Intertidal | Y | Y | Y | Y | Y | Y | Y |
| Tiny[2/] | | | | | | | |
| Torrent | Y | | | | Y(r) | | |
| West Fork Luck Creek | Y | Y | Y | Y | Y(a,r) | Y(a,r) | Y |
| West Fork North Thorne | Y | | Y | Y | Y(a,r) | Y(a,r) | Y |

Source: ADF&G Anadromous Waters Catalog (http://www.ADF&G.alaska.gov/sf/SARR/AWC); Forest Service Field Sampling data, RCS data

1/ All fish are assumed to be anadromous unless indicated by “a” for anadromous or “r” for resident as determined by Forest Service field data collection and RCS database

2/ ADF&G Anadromous Fish Catalog have no data for these subwatersheds and Forest Service fish surveys found no fish for these subwatersheds.

This species is ubiquitous in Southeast Alaska (Carls et al. 2008). Juvenile herring typically spend their first 3 years of life in nearshore regions commonly utilizing bay areas. As they grow they reside in deeper offshore waters. They are primarily a pelagic species. Sampling has been limited in the shoreline areas near the project area, so exact distribution in this region is also limited. Spawning has been documented near Craig/Klawock and Thorne Bay (Pritchett 2006 as cited in Carls et al. 2008). Thus this species may occur in shoreline areas in the vicinity of the project.

During February and March, herring concentrate near the bottom (at 200 to 300 feet) off traditional spawning beaches. They remain there until late April, when sea-surface temperatures increase and then move into tidal shallows to commence spawning, which typically takes place over a 2- to 3-week period between late April and early May. After spawning, the adult herring return to deep-water areas. Herring spawning typically takes place in nearshore habitat. Additionally, juvenile herring spend early years rearing in nearshore waters feeding on pelagic plankton commonly in bays of Southeast Alaska.

### Subsistence Fish

ANILCA requires that Federal agencies with jurisdiction over public lands in Alaska analyze subsistence resources and their uses and evaluate potential effects of management activities on these resources and uses (ANILCA Sec. 810). This analysis typically focuses on food-related resources that are most likely to be affected by habitat loss or alteration associated with land management activities. Fish subsistence uses are described in Issue 3 of this chapter and in the Fisheries Resource Report (Knutzen 2013).

### Acid Rock Drainage (ARD)

ARD has been an issue for fish resources from past road construction actions in one known region of the Prince of Wales Island. ARD is created when iron pyrite, oxygen, and water combine to produce acidified water that dissolves metal compounds resulting in elevated dissolved metal concentrations in water. About 15 percent of the project area contains rock type (Descon Formation) that has some potential to contribute to ARD. Based on recent past road construction, ARD could occur under certain conditions. The details of potential for ARD in the project area are presented under Issue 4**.** During the construction of a road to Coffman Cove (FS Highway 3030), some issues with ARD were found and ultimately remedied. Surveys that were conducted on the ten streams crossed by the ARD-affected 3.5-mile road segment recorded the presence of an orange precipitate in the channels downstream of the road. These stream reaches had elevated metals levels and fish avoided those areas, while fish were present in streams outside of those crossed by 3.5-mile road segment (AMEC 2008). Remediation occurred along the 3.5-mile road segment and subsequent sampling of the streams crossed by this segment found that pH and other constituents in the streams returned to normal levels. The orange precipitate was dissipated and invertebrate populations were similar to unaffected areas, and fish returned to the stream regions crossed by the affected road segment (AMEC 2008).

Existing Forest roads and quarries in the project area are constructed from the Descon Formation. It is estimated that 253.8 miles of existing road likely constructed from the Descon Shale exist within the project area. It is not known if the material sources used in this construction contained mineralization. However, no past problems other than those noted above have been observed (Baichtal personal comm. 2011, as cited in Barnhart and Hitner 2013b).

## Stream Crossings

In the Big Thorne project area, surface road erosion and road prism failures are probably the dominant process by which management disturbance results in occasional sedimentation events. These processes are discussed and effects estimated in the Issue 4 section above.

The Aquatic Habitat Management Handbook (USDA Forest Service 2001a) specifies guidelines for fish passage through culverts. These guidelines will be followed in all proposed road reconstruction and new road construction in the Big Thorne project area.

The guiding criterion for culvert design is to allow for natural migration by adult and juvenile fish through the culvert during various flows. The Tongass National Forest developed a juvenile fish passage evaluation criteria matrix with an interagency group of professionals. The evaluation matrix stratifies culverts by type, and establishes thresholds for culvert gradient, stream channel constriction, debris blockages, and vertical barrier (or perch) at culvert outlet. Culvert categories are:

- **Green:** conditions that have a high certainty of meeting adult and juvenile fish passage requirements at all desired stream flows;
- **Gray:** conditions are such that additional analysis is required to determine juvenile fish passage ability; and
- **Red:** conditions that have a high certainty of not providing juvenile fish passage at all desired stream flows.

Most fish stream crossing structures on roads in the Big Thorne Project have been surveyed and categorized as green, gray, or red. Some culverts designated as red may not impede larger fish and may pass fish of all sizes during certain stream flow levels. There were 155 red crossings in the project areas when studies began for the Big Thorne Project and all have known fish populations upstream (Table FISH-6). There are approximately 12 miles of Class I and 22 miles of Class II fish habitat upstream of these red crossings, which represent about 5 percent of the known fish habitat in the project's subwatersheds. Four of these culverts are still in place on temporary roads that have already been decommissioned, while the rest are on open roads. See the Fish Passage section below for details on future plans for red culvert treatment.

**Table FISH-6.** Fish Passage in the Project Area by Subwatershed

| Subwatershed | Number of Fish Crossing by Category | | | | Fish Habitat Upstream of Red Culverts (miles)[1/] | | |
|---|---|---|---|---|---|---|---|
| | Total | Green | Gray | Red[2/] | Class I | Class II | Total |
| Baird Peak | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Barren | 7 | 5 | 0 | 2 | 0.00 | 0.63 | 0.63 |
| Big Ratz | 28 | 18 | 1 | 9 | 0.17 | 1.04 | 1.21 |
| Central Thorne River | 20 | 7 | 0 | 13 | 2.65 | 3.13 | 5.79 |
| Cobble Creek | 9 | 5 | 2 | 2 | 0.00 | 0.43 | 0.43 |
| Control Lake | 13 | 4 | 2 | 7 | 0.00 | 1.49 | 1.49 |
| Deer Creek | 19 | 9 | 2 | 8 | 0.00 | 3.55 | 3.55 |
| Doughnut | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Eagle Creek/Slide Creek | 15 | 10 | 0 | 5 | 0.19 | 0.55 | 0.74 |
| East Fork North Thorne | 23 | 11 | 0 | 12 | 1.14 | 0.37 | 1.51 |
| Falls Creek | 1 | 1 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Goose Creek | 14 | 6 | 0 | 8 | 2.78 | 0.78 | 3.56 |
| Gravelly Creek | 21 | 9 | 0 | 12 | 0.00 | 0.96 | 0.96 |
| Lake Ellen | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Little Ratz Creek | 14 | 8 | 1 | 5 | 0.04 | 0.67 | 0.72 |
| Luck Lake | 14 | 6 | 0 | 8 | 0.00 | 1.20 | 1.20 |
| Luck Point | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| No Name | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| North | 5 | 0 | 0 | 5 | 0.11 | 0.85 | 0.96 |
| North Big Salt Lake | 14 | 6 | 0 | 8 | 1.61 | 1.04 | 2.65 |
| North Kasaan Bay Frontage | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| North Sal | 1 | 0 | 1 | 0 | 0.00 | 0.00 | 0.00 |
| Pin | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Ratz Harbor | 8 | 2 | 1 | 5 | 1.19 | 0.51 | 1.70 |
| Rio Beaver Creek | 17 | 11 | 0 | 6 | 0.32 | 0.35 | 0.67 |
| Sal Creek | 12 | 8 | 2 | 2 | 0.00 | 0.16 | 0.16 |
| Salamander | 7 | 0 | 0 | 7 | 0.00 | 2.14 | 2.14 |
| Slide Creek | 26 | 21 | 0 | 5 | 0.00 | 0.78 | 0.78 |
| Snakey Lakes Lowlands | 22 | 11 | 0 | 11 | 0.44 | 0.75 | 1.19 |
| Thorne | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Thorne Bay | 3 | 1 | 0 | 2 | 0.00 | 0.55 | 0.55 |
| Thorne Lake | 3 | 2 | 0 | 1 | 0.00 | 0.02 | 0.02 |
| Thorne River Intertidal | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Tiny | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Torrent | 1 | 1 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| West Fork Luck Creek | 23 | 11 | 1 | 11 | 0.65 | 0.30 | 0.94 |
| West Fork North Thorne | 8 | 7 | 0 | 1 | 0.40 | 0.00 | 0.40 |
| TOTAL | 348 | 180 | 13 | 155 | 11.69 | 22.27 | 33.96 |

1/ Upstream habitat distance for some crossings estimated by GIS analysis for this project assessment.
2/ Up to 13 of these will have been removed or replaced with fish passable structures by 2014 (see Fish Passage subsection).

## Environmental Consequences

See the Issue 4 section for the effects analysis of stream habitat, water quality, and water yield.

### Effects Common to all Action Alternatives

#### Young-Growth Harvest

Some of the proposed harvest in Alternatives 3, 4, and 5 would include commercial thinning of young growth. Commercial thinning would remove trees of commercial harvest size while providing the remaining trees enhanced conditions to accelerate growth. RMAs would be treated the same as standard practices for timber harvest including buffering. Commercial thinning would be equivalent to harvest practices that remove about 35 percent of the forest canopy and general effects to fisheries resources would be similar to those for partial harvest of old growth with proper implementation of standards and guidelines and BMPs. The effects for commercial thinning were accounted for in the analysis of potential effects to aquatic systems as addressed in Issue 4 above.

#### Large Woody Debris

In all alternatives, the standards and guidelines for the RMAs will be followed. The design of RMA buffers is described in the unit cards in Appendix B of the Draft EIS (Draft EIS unit cards) and in the project record (Final EIS unit cards). These site-specific designs are expected to effectively protect water quality and fish habitat. LWD recruitment and spacing would remain, therefore having no direct or indirect effects and thus no cumulative effects on fish habitat.

#### Windthrow

The IDT considered windthrow risk and precautionary measures to protect RMAs; this is discussed in detail in the Silviculture section of this chapter. The specific application of the RMA is described for each unit in the unit cards descriptions.

#### Fish Passage

The discharge of dredge or fill material resulting from normal silviculture activities and the construction or maintenance of forest roads is exempt from permitting requirements under Section 404 of the CWA as long as roads are constructed in accordance with BMPs. Providing for fish passage is one such BMP.
All fish stream crossings installed on new roads in all action alternatives will be designed to meet fish passage standards. In addition, all structures will be removed from new temporary roads and these roads will be decommissioned when their use period is over. The action alternatives are expected to result in no measureable direct or indirect effects to fish passage in the project area, as all new fish streams crossings will be crossed with log culverts or bridges. The number of fish streams crossed by alternative is provided in Table WTR-8 under Issue 4.

Additionally, all red crossings that are on roads designated to remain open independent of the project are prioritized on a Forest level to determine the appropriate management plan. Limited funds are allocated by Congress for this purpose, and will be appropriated according to priorities across the Forest. Those red crossings not replaced or removed will continue to impede fish migration at certain flows and life stages until they are replaced or removed.

As noted in the Affected Environment section, a total of 155 red culverts were present at the start of project studies in the project area that inhibit access to fish habitat (Table FISH-6). However, some of the 155 culverts have or will be removed and replaced prior to the start of Big Thorne Project so that miles of stream affected by red culverts will be less than indicated here. These culverts inhibit access to about 34 miles of fish habitat, about 12 and 22 miles of Class I and II habitat, respectively (Table FISH-7). Currently, the Central Thorne River and Goose Creek subwatersheds have the most habitat of all subwatersheds with impeded or blocked passage at 5.8 and 3.6 miles, respectively. The Fisheries Resource Report (Knutzen 2013) supplies information on subwatershed and road locations for each of these red culverts. The status of some red culverts will change from those currently scheduled under the No-action Alternative by each action alternative. Any red culvert on a road that had been designated for storage but that is used by the project will be considered for removal at the end of the project (Table FISH-7). A table has been added to the Big Thorne Project record that is being used to aid in prioritizing culvert remediation of red pipes on specific, alternative reconstructed roads for early removal or storage, within 1 to 5 years after project completion. It develops an overall rating for each crossing based on several factors including ease of potential passage at the current culvert and quality and quantity of upstream habitat affected.

In the No-action Alternative, roads would be stored or decommissioned or culverts replaced under the Prince of Wales ATM, and culvert status considered on a case-by-case basis, when funding becomes available. When roads are stored, red pipes may be removed depending on funding availability. There are 36 red crossings on roads that are proposed for storage under the Prince of Wales ATM in the Big Thorne project area (Table FISH-7). The storing of these roads would reconnect some of the drainage patterns in the subwatersheds and improve access up to approximately 6.4 miles of upstream habitat when all red culverts are removed, based on the completed upstream habitat assessments and GIS queries as shown in Table FISH-7. There are 106 red culverts blocking nearly three-fourths of all passage-impeded fish habitat (22.9 miles) in the project area that will be prioritized for replacement independent of project actions (Table FISH-7). There are 13 red culverts, many on existing roads that are to remain open independent of project actions, that have been in the process of removal or replacement during the Big Thorne Project studies. These are designated as the “In Process” culverts in Table FISH-7. Most have been removed or replaced while some are still under contract to be removed in the near term. The replacement or removal of these culverts will add 4.66 miles of accessible habitat (Table FISH-7) (see Fisheries Resource Report for details [Knutzen 2013]).

**Table FISH-7.** Changes in Red Culvert Status by Alternative in the Big Thorne Project Area

| Planned Culvert Status[1/] | Upstream Class | Number of Red Culverts and Miles of Upstream Fish Habitat [2/] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | | Alternative 5 | |
| | | Number | Miles | Number | Miles | Number | Miles | Number | Miles | Number | Miles |
| Potential Project Removal | I | 0 | 0.00 | 1 | 0.05 | 2 | 0.13 | 2 | 0.13 | 1 | 0.05 |
| | II | 0 | 0.00 | 15 | 3.08 | 21 | 4.07 | 16 | 2.85 | 16 | 3.08 |
| | I&II | 0 | 0.00 | 16 | 3.13 | 23 | 4.19 | 18 | 2.97 | 17 | 3.14 |
| Planned Removal | I | 4 | 0.47 | 3 | 0.42 | 2 | 0.34 | 2 | 0.34 | 3 | 0.42 |
| | II | 32 | 5.94 | 17 | 2.86 | 11 | 1.88 | 16 | 3.10 | 16 | 2.86 |
| | I&II | 36 | 6.41 | 20 | 3.28 | 13 | 2.22 | 18 | 3.44 | 19 | 3.28 |
| In Process | I | 3 | 1.60 | 3 | 1.60 | 3 | 1.60 | 3 | 1.60 | 3 | 1.60 |
| | II | 10 | 3.07 | 10 | 3.07 | 10 | 3.07 | 10 | 3.07 | 10 | 3.07 |
| | I&II | 13 | 4.66 | 13 | 4.66 | 13 | 4.66 | 13 | 4.66 | 13 | 4.66 |
| Prioritized Replacement | I | 25 | 9.63 | 25 | 9.63 | 25 | 9.63 | 25 | 9.63 | 25 | 9.63 |
| | II | 81 | 13.26 | 81 | 13.26 | 81 | 13.26 | 81 | 13.26 | 81 | 13.26 |
| | I&II | 106 | 22.88 | 106 | 22.88 | 106 | 22.88 | 106 | 22.88 | 106 | 22.88 |
| **Total** | I | 32 | 11.69 | 32 | 11.69 | 32 | 11.69 | 32 | 11.69 | 32 | 11.69 |
| | II | 123 | 22.27 | 123 | 22.27 | 123 | 22.27 | 123 | 22.27 | 123 | 22.27 |
| | I&II | 155 | 33.96 | 155 | 33.96 | 155 | 33.96 | 155 | 33.96 | 155 | 33.96 |

1/ Status Definitions:

**Potential Project Removal** = those on existing system roads that had been planned for storage but will be used by the project will be considered for removal at project end. Recommendations for priority removal of some of those that are on reconstructed roads are included in road cards.

**Planned Removal** = those on roads planned for storage, but dependent on future funding.

**In Process** = since the initiation of the Big Thorne Project evaluation, these culverts were either replaced/removed or are under contract to do so.

**Prioritized Replacement** = those on roads that will remain open. They will be prioritized forest wide for replacement and dependent on future funds.

2/ Upstream habitat distance estimated by GIS analysis for some culverts for this project assessment (see Fisheries Resource Report [Knutzen 2013])

Source: Forest Service developed RCS data file: CMP_2012_Replacement.shp

No alternatives would affect scheduling of the 13 red culverts designated as In Process for replacement or removal that is ongoing or the 106 culverts on existing roads that will be prioritized in the future for replacement. However, among the action alternatives, a portion of the remaining 36 culverts that have been designated for planned removal would be removed at project completion. Initial prioritization of early removal (i.e., within the early part of the 1- to 5-year removal period) of red culverts on roads to be reconstructed as part of the respective alternatives has been developed and included in road cards. A total of nine red culverts, which would be present on reconstructed roads, have been prioritized (e.g., low to high rating) among the various alternatives for their potential for early removal or replacement (Knutzen 2013). Within 1 to 5 years after harvest, all project roads would be stored and temporary roads decommissioned after their use period is over, resulting in removal of the respective red culverts, reconnecting drainage patterns in the subwatersheds, and improving access to a portion of these streams. Alternative 3 influences access to the greatest amount of habitat (4.19 miles) above 23 red culverts and would increase access to the greatest portion of habitat when the red culverts were removed. Alternatives 2, 4, and 5 would have similar improvements on habitat access, including about 3 miles of primarily Class II fish habitat (Table FISH-7). None of the action alternatives could affect access to a substantial amount of Class I habitat (0.13 mile or less for all action alternatives) when all of these Class I culverts were replaced. Central Thorne River and North Big Salt Lake subwatersheds have the most fish habitat (1.2 and 1.0 miles, respectively) that would potentially be reconnected to downstream fish populations for Alternatives 2, 3, 4, and 5. As noted, early removal prioritization, based on potential amount of upstream habitat that could be reconnected from red culvert removal and other factors, has been developed and is included in the road cards.

Overall, there is little difference between the action alternatives as none of the project alternatives would have a marked effect on potentially restoring access to fish habitat upstream of red culverts in the project area. Under the action alternatives, about 3 to 4 miles of habitat at most would have fish passage access improved within 5 to 15 years. Similar passage access may occur under the No-action Alternative but it depends on future non-project funding. Limited Class I habitat will also be gained under any alternative (Knutzen 2013).

The effects of the Old-growth Reserve change on fish habitat and fish resources is discussed in the Environmental Consequences section in Issue 2 above, and will not be repeated here. Similarly, direct, indirect, and cumulative effects to aquatic habitat can be found in the Environmental Consequences section under Issue 4 above and no further discussion is provided in this section.

## Essential Fish Habitat Assessment

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act states that all Federal agencies must consult NMFS for actions and proposed actions that may adversely affect essential fish habitat (EFH) for federally managed marine and anadromous fish species. Following our 2007 agreement with the NMFS, the EFH Assessment was included in the Draft EIS and summarized here. The Forest Service determined that the Big Thorne Project may adversely affect freshwater and marine EFH. The EFH species potentially affected in the freshwater and marine enviromnents are listed in the Draft EIS.  Comments were not received from the NMFS.  The Forest Service contacted Cindy Hartman of NMFS and confirmed they had received the Draft EIS document including the EFH assessment and was informed that NMFS had not submitted comments for the Big Thorne Project (D. Brigham, USDA Forest Service, personal comm. with C. Hartman, NMFS, 2013).  This satisfies the EFH consultation requirement based on the 2007 Agreement with NMFS and concludes the formal consultation process.

### *Freshwater EFH*

In the EFH assessment, the Forest Service determined that the Big Thorne Project may adversely affect EFH because fish streams are directly affected stream crossings or indirectly affected by harvest.  All action alternatives would result in minor effects on water quality and aquatic habitat.  These potential impacts include increased peak flows, increased sediment delivery, altered riparian vegetation (Class IV streams and new road stream crossing), and disturbed channel integrity (see Issue 4).  A more complete discussion of potential adverse effects, including cumulative effects, of the proposed action on freshwater EFH is included in the Issue 4 section of Chapter 3 of this document.

While all of these effects are minor, they will have some short-term adverse effects to migratory, spawning, and rearing habitat for anadromous salmonids.  However, by following the standards and guidelines and BMPs in the Forest Plan, the effects on EFH would be minimized for the following reasons:

- All newly constructed and reconstructed NFS system roads that are used for the Big Thorne Project would be stored within 1 to 5 years after timber haul and associated activities are complete   Temporary roads would be decommissioned after timber harvest is complete.  Priority fish passage structures on newly constructed temporary roads would be removed in all alternatives.  Any impassable existing culverts (i.e., red pipes) on constructed and reconstructed roads that are stored or decommissioned through this project would be removed as part of storage/decommissioning activities.
- All Class I and II streams in the Big Thorne project area would be protected by a minimum no-cut buffer of 100 feet with additional RMAs protected depending on process groups, sensitive riparian soils, elevated windthrow concern, and other relevant resource concerns according to the Forest Plan and Tongass Timber Reform Act.
- Class III streams would be protected at least by a no-harvest buffer to the top of the side slope (v-notch) according to the Forest Plan (USDA Forest Service 2008b).
- Additional precautionary measures would be prescribed to minimize windthrow in RMA buffers where the risk of windthrow is high or where extensive windthrow has occurred.  These measures include retaining additional trees adjacent to the RMA to help ensure resistance to windthrow through implementation of RAW buffers.
- New road construction contracts will include corrective actions for existing erosion features.

- Full channel spanning bridges or log culverts would be placed over fish streams on new road crossings and constructed roads over existing road prisms to avoid risks of channel disturbance and culvert blockage. Priority crossings on system roads would be removed when roads are stored.
- The temporary roads will be decommissioned following use for this timber sale and culverts will be removed.
- BMPs would be implemented to protect water quality and aquatic habitat protection for all freshwater streams within the project area. See unit cards (Appendix B of the Draft EIS; project record for Final EIS cards) for specific applications of BMPs.
- Any rock sources from Descon Shale area Formation used for road surfacing and road construction in all alternatives would be assessed as to its ARD potential to minimize effects on pH and dissolved metals concentrations in streams on the project area.

#### *Marine EFH*

The Forest Service determined that the Big Thorne Project may adversely affect marine EFH in the project area. Adverse effects include diminished habitat for managed species and their prey and reduced rearing capability for juvenile salmon due to potentially reduced water quality. Water quality effects include fuel spills from equipment used for loading barges which are likely to be limited in both quantity and distribution as most activity and spills would be on shore having only localized effects to nearshore fish and fish food resources from runoff to the marine environment. Another potential adverse effect is reduced prey abundance that may occur because of lower primary production in the water column from shading by barges and equipment floats. Impacts to these waters are expected to be minimal for the following reasons:

- Standards and guidelines of the Forest Plan and implementation of BMPs would be used at the Thorne Bay facility
- Coffman Cove and Thorne Bay MAFs are barge loading–only facilities greatly reducing potential for adverse bark accumulations and they would be the most viable options for a timber purchaser to move logs off Prince of Wales Island.

The Forest Service determines that by implementing Forest Plan standards and guidelines, BMPs, and project-specific mitigation, effects to essential fish habitat would be minimized under all action alternatives. Additional impacts to EFH are likely to occur only from unforeseen events such as landslides, debris blockages of culverts, fuel spills, and road failures.

### Threatened, Endangered, and Proposed Listed Fish or Sensitive Fish Species

Pacific herring rearing, feeding and spawning habitat can be adversely affected by actions that add sediment such as dredging, reduce water quality such as oil spills, nearshore habitat modification including log storage, and other related construction actions like boat traffic and noise (Carls et al.1999; Misund et al. 1996; Vabo et al. 2002; Barnhart 1988; NOAA Fisheries 2012). To the degree that these activities occur in association with this project, the potential exists for impact. However, currently implemented standard BMPs during all project phases would greatly reduce the potential for these types of impacts. Log transport activities at the potential MAFs of Prince of Wales Island may have some effect on nearshore habitat use by juvenile herring as well, although the effect would be very minor and infrequent.

In summary, Alternative 1 would not affect Southeast Alaska DPS Pacific herring, a Tongass National Forest Sensitive species, because no action would be undertaken. Under Alternatives 2, 3, 4, and 5, Pacific herring is unlikely to have substantial adverse effects as direct spawning disruption is unlikely to occur from specific actions at any of the MAF and effects to rearing habitat quality and quantity would be slight and infrequent from all potential project actions.

Also, the presence of Threatened or Endangered salmon and steelhead from the Pacific Northwest has commonly been documented for Southeast Alaska inside channels. Occurrence near project-affected areas and facilities is unknown, but may be uncommon (Tucker et al. 2011; Oris and Jaenicke 1996; Trudel et al. 2009; McNeil and Himsworth 1980). The Threatened green sturgeon (Southern DPS) may also be present in the project area or facilities but rarely (Colway and Stevenson 2007; Lindley et al. 2008; Huff et al. 2012). No critical habitat has been designated for these species in Alaskan waters. Based on the 2008 Forest Plan (USDA Forest Service 2008c), any proposed actions indirectly resulting from the Forest Plan will be evaluated on a case-specific basis as to their effect on listed species and may include formal or informal consultation with NMFS at the time of project evaluation. This will include the development in a report called a Biological Assessment (BA). A completed BA/BE (Biological Evaluation) for the Big Thorne Project, which includes Federal ESA listed and candidate fish species and Forest Service sensitive species that may be near the proposed project, is included in a separate document in the Big Thorne Project record. The conclusion of the BA, which considered the actions of all alternatives, is that the project would not cause any adverse effects to federally listed fish species, resulting in "no effects" or "not likely to adversely affect" determinations depending on the species. The conclusion in the BE for the Forest Service sensitive Pacific herring is "may impact individuals but not likely to result in a loss of viability in the Planning Area, nor cause a trend toward Federal listing."

# Wetlands

## Introduction

This section summarizes wetland resources in the project area. Wetlands are defined by the Tongass Forest Plan, U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency (EPA) as “those areas that are inundated or saturated by surface water or groundwater with a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions” (33 CFR 328.3; 40 CFR 230.3). The three widely accepted functions that wetlands may provide are water quality improvement, hydrologic functions, and wildlife habitat. Wetlands may reduce flooding, improve water quality through sequestration of physical (sediment) and chemical contaminants in the water, and provide habitat for a variety of plants and animals.

Management activities on NFS lands are required to comply with the Forest Plan and Federal and State laws. Relevant standards and guidelines and regulations intended to protect wetlands include the Tongass Forest Plan; Executive Order 11990 (Protection of Wetlands), and the CWA. Wetlands are extensive in the project area, covering more than half of the land area. Due to the extent of wetlands in the project area and because forested wetlands are managed for their timber resources, complete avoidance of wetlands during road planning and construction is not feasible. However, higher-value and rare wetlands such as estuaries and tall sedge fens have been avoided. Where a wetland cannot be avoided, the impacts are to be minimized. Best management practice (BMP) 12.5 provides guidance for wetland information, evaluation, and protection.

Wetland type and extent were estimated based on the Tongass Wetland Mapping layer and field verified in about 85 percent of the old-growth units. The young-growth units have been reviewed and selected units were field verified; additional field review for these units would be conducted upon implementation. Wetlands were classified according to the Tongass Wetland Classification System (DeMeo and Loggy 1989). Additional detailed information regarding the regulatory framework, methodology, and analysis of wetlands in the project area can be found in the Soil and Wetland Resource Report (Cox et al. 2013).

## Affected Environment

Approximately 55 percent of the project area (127,386 acres) is covered by wetland. Wetland types are interspersed throughout the project area, although some wetland types tend to be more common in some portions of the project area. Forested wetlands comprise about 25 percent of the project area and are particularly common in the southern third of the project area. Forested wetland/emergent short sedge complex wetlands comprise about 13 percent of the project area and are common along the eastern and western edges of the project area. Non-forested wetland types comprise 18 percent of the project area and are interspersed throughout the project area, although alpine wetland is particularly common in the north-central portion of the project area. Wetland types are described in detail in the following sections.

## Wetland Types

### *Forested Wetland*

Forested wetlands are wetlands dominated by vegetation greater than 20 feet in height. In the project area, species composition of the overstory is varied and may contain the following species: western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), shore pine (*Pinus contorta)* and yellow-cedar (*Callitropsis nootkatensis*). The understory is often dominated by skunk cabbage (*Lysichitum americanum*) and deer cabbage (*Nephrophyllidium crista-galli*). Forested wetlands occur on poorly or very poorly drained hydric mineral and organic soils. Forested wetlands are most common on broad glacial valley bottoms, gently sloping hill slopes or benches, but are also commonly found on steep terrain in areas overlaying volcanic geology. Forested wetlands provide important functions including wildlife habitat, water quality improvement, peak flow reduction and erosion control, organic matter production and export, and nutrient and carbon cycling (Cooke 2005). Forested wetlands may support the transfer of water to downslope resources, function as recharge areas for groundwater and streams, and provide depositional areas for sediment and nutrients. The project area contains 57,450 acres of forested wetland, comprising approximately 25 percent of the land area in the project area.

### *Forested Wetland/Emergent Short Sedge Complex*

The forested wetland/ emergent short sedge complex is less than 50 percent forested. The forested wetland and emergent short sedge wetlands are so intermixed that they cannot be mapped at a small scale. Forested wetland/ emergent short sedge complexes share characteristics of both forested wetland and emergent short sedge types. Sphagnum mosses, sedges, and skunk cabbage dominate these wetlands with low volume class hemlock, cedar, and pine. Soils are very poorly drained hydric organic soils, with occasional hydric mineral soils in small pockets of forested wetland. These complexes are commonly found in riparian areas and occur in gently sloping hill slopes and benches, glacial valley bottoms, lower foot slopes, and on broad ridge tops. Both complexes contribute to the transfer of water downslope, groundwater and stream recharge, and carbon and nutrient cycling. These complexes provide terrestrial and aquatic habitat for wildlife species, such as black bear, deer, and mink. The forested wetland/emergent short-sedge complex is the second most abundant type of wetland in the project area and covers approximately 29,361 acres and 13 percent of the project area.

### *Emergent Short Sedge Wetland*

Emergent short sedge wetlands contain organic soils that are very poorly drained, moderately deep and are dominated by short sedges and mosses, although there are often patchy areas of shrubs and shore pine. They may include poor fens and rich bogs and there is typically some water flow through. Emergent short sedge wetland is often found on lower footslopes, in valleys, and on broad ridge tops. These wetlands provide habitat for distinctive plants and animals and contribute water to downslope resources, provide carbon and nutrient cycling benefits for watershed function, provide water storage for flood and erosion control (EPA 2011). These wetlands cover approximately 10,085 acres (4 percent of the project area).

### *Emergent Tall Sedge Fens*

Emergent tall sedge fens are characterized by a diverse community of sedges, dominated by tall sedges such as Sitka sedge, with a variety of forbs and occasional stunted trees, usually spruce or hemlock. Soils are typically deep organic muck, often with some thin layers of alluvial mineral soil material. They occur in landscape positions where they receive some run-off from adjacent slopes resulting in somewhat richer nutrient status than bogs. These wetlands function as areas of recharge of groundwater and streams, deposition and storage of sediment and nutrients, and for waterfowl and terrestrial wildlife habitat, including black bear, mink, river otter, and beaver. Tall sedge fens are located in areas with water flow through and many contain beaver ponds; the open water component provides habitat for a variety of wildlife including waterfowl, beaver, otter, and fish. Tall sedge fens account for about 2,549 acres (1 percent) of the project area.

### *Alpine Muskeg*

Alpine muskegs are similar to emergent sedge and muskeg complexes; however, they occur at higher elevations in the landscape, such as ridge tops and mountain summits and are typically closed hydrologic systems. Alpine muskegs are dominated by sphagnum moss with a wide variety of other plants adapted to very wet, acidic, organic soils. Vegetation is a combination of muskeg and sedge meadows of peat deposits, and low-growing blueberry and heath on higher rises. Similar to muskeg, stunted trees less than 15 feet high are common. Alpine muskegs are important for snow storage and can be a source for snowmelt water throughout the spring and early summer months. These wetlands also provide summer habitat for wildlife. Alpine muskeg wetlands cover approximately 20,653 acres (9 percent) of the project area.

### *Moss Muskeg*

Moss muskegs are characterized by nutrient-limiting acid peat bogs, dominated by sphagnum moss and peat deposits. Muskeg wetlands support a distinctive flora which are adapted to life in these acidic, wet, low-nutrient environments (EPA 2011). Common plants include ericaceous shrubs such as cranberry (*Vaccinium oxycoccos*) and blueberry (*Vaccinium spp.*), cottongrass (*Eriophyllum* spp.), Labrador tea (*Ledum grandifolium*), and sundews (*Drosera* spp.) and occasional stunted trees, particularly shore pine (*Pinus contorta*), may also be present. Soils are typically organic peat deposits and accumulate over unconsolidated glacial till or impermeable glacial silts, typically on gentle or nearly level slopes. Moss muskegs often have no significant inflow or outflow of water other than precipitation, thus ponded areas, a result of a high water table, occur within the wetland. These wetlands function as areas of surplus water and peat accumulation creating a stable microclimate and habitat for waterfowl and wildlife, including cranes, black bear, amphibians, mink, and deer. Moss muskegs account for approximately 7,240 total acres (3 percent) of the project area.

### *Estuaries*

Estuaries are intertidal zones where brackish saltwater mixes with fresh water from rivers or streams. They are the least represented type of wetland on the project area supporting complex and productive ecosystems for vegetation, fish and wildlife. There are two types of estuarine wetlands: emergent wetlands in the upper tidal zone, and intertidal, regularly flooded zones. The emergent wetlands are characterized by grasses and sedges, especially tufted hairgrass (*Deschampsia caespitosa*), Lyngby's sedge (*Carex lyngbei*) and dune wild rye (*Leymus mollis*) in the upper tidal zone. The intertidal, regularly flooded zone largely comprises aquatic algal beds and rocky or unconsolidated shore. The Forest Service manages the estuarine wetlands above mean high tide (USDA Forest Service 2008a). The Forest Plan standards and guidelines give estuaries a 1,000-foot buffer. Estuaries cover approximately 47 acres in the project area.

## Past Activities that affected Wetlands

The majority of wetlands in the project area are undisturbed and intact. However, because 55 percent of the project area is covered by wetlands, total avoidance has not been practicable. Past impacts include forested wetlands that were previously logged as well as road construction through wetlands. Previously logged forested wetlands are in the process of regenerating, and support young forests. Past road construction in wetlands is considered a permanent wetland impact.

### *Road Construction*

Roads across sloping wetlands may affect hydrologic connectivity across the wetland due to road ditches or road fills. A total of 1,113 acres of wetland have been replaced by roads in the project area. Road building on wetlands has occurred primarily on forested wetland (about 691 acres) and forested wetland/ emergent short sedge wetland (301 acres), covering about 1 percent of each wetland type in the project area. Forested wetlands and forested wetland/ emergent short sedge wetlands are common, covering nearly 25 and 13 percent of the project area, respectively. About 120 acres of a combination of tall sedge fen, emergent sedge fen, moss, and alpine muskeg wetlands have been converted to road, less than 1 percent of the total acreage of these wetland types.

Use of coarse, permeable shot rock and fill and adequate cross drainage minimizes the impacts to wetland hydrology. Based on research regarding the effect of road construction impacts on adjacent wetlands in Southeast Alaska (Glaser 1999; Kahklen and Moll 1999; McGee 2000), effects to wetland hydrology and vegetation adjacent to these roads are expected to be limited to a few meters of the road. Table WET-1 displays the existing acreage and miles of wetlands impacted by roads.

The Tongass National Forest has conducted implementation and effectiveness monitoring of wetland BMPs. This monitoring was conducted in 2006, 2008, and 2011. In 2011, new road construction and roads constructed more than 30 years ago were reviewed. The most recent 2011 monitoring assessment indicates that wetlands were avoided to the extent practicable while meeting project goals and objectives and impacts to wetlands were minimized. The 2011 monitoring displayed a high rate of implementation of the 15 Federal baseline provisions (Landwehr 2011a). The 2006 and 2008 monitoring showed similar results.

### *Past Harvest*

Timber harvest on wetlands has temporary effects on wetland hydrology. Rainfall interception studies (Patric 1966; Beaudry and Sagar 1995; Banner et al. 2005) indicate that the amount of rainfall hitting the soil surface will increase following clearcutting. Soils within harvested sites tend to gain higher moisture levels resulting in slower growth in the seedling and sapling stage. Soil moisture conditions remain elevated until evapotranspiration surfaces in the canopy of a young stand become equivalent to pre-harvest conditions. Depending on the soil moisture status of the wetland, this effect can range from negligible to lasting more than 20 years. In partially harvested stands, retention of a portion of the canopy cover would help minimize the effect of timber harvest on soil moisture. Many of the forested wetlands on the Big Thorne project area support commercial stands of timber. Some of these stands have been harvested in the past and some are proposed for harvest in this EIS. Table WET-1 displays the existing acres of wetlands harvested by wetland habitat type.

**Table WET-1.** Existing Road Construction and Timber Harvest on Wetlands

| Habitat Type | Total Acres in Project Area | Road Construction | | | Timber Harvesting | |
|---|---|---|---|---|---|---|
| | | Acres Altered by Road Construction | Percent of Wetland Type Altered by Road Construction in Project Area | Miles of Road | Acres Harvested[1/] | Percent of Type Harvested in Project Area |
| Moss Muskeg[2/] | 7,240 | 61 | 0.8% | 12.8 | 594 | 8% |
| Alpine Muskeg[2/] | 20,653 | 6 | <0.1% | 1.2 | 53 | 0.3% |
| Emergent Tall Sedge Fen[2/] | 2,549 | 6 | 0.2% | 1.2 | 127 | 5% |
| Emergent Short Sedge Fen[2/] | 10,085 | 47 | 0.5% | 9.8 | 280 | 3% |
| Forested Wetland/ Emergent Short Sedge Complex | 29,361 | 301 | 1.0% | 62.6 | 2,740 | 9% |
| Forested Wetland | 57,450 | 691 | 1.2% | 143.2 | 10,077 | 18% |
| Estuarine | 48 | 0 | 0 | 0.1 | 13[3/] | 28% |
| **Totals[4/]** | **127,385** | **1,113** | **0.9%** | **230.9** | **13,884** | **11%** |

1/ Acres of harvest on non-forested wetland are due to small inclusions of forest land within a wetland map unit that is typically non-forested, or small inclusions of non-forested wetland on the edges of or inside harvest units.
2/ Harvested acres of non-forested wetland included due to inclusions of small areas within past harvest units.
3/ Harvested prior to forest plan requirements that prohibit harvesting in estuaries.
4/ Sums may differ due to rounding

## Wetland Avoidance

The extent of wetlands in the project area has resulted in past wetland impacts. Approximately 40 percent of existing roads in the project area are in wetlands and 55 percent of the project area is wetland. Thus, it can be concluded that past road construction activity has avoided wetlands where practicable, because the proportion of roads in wetlands is lower than the proportion of roads in the project area. Wetland impacts have occurred as a result of the extensive, interspersed wetland coverage in the project area and the location of harvestable timber. Access to timber through road construction on wetlands is often the most economically viable and lowest overall impact option. Wetland impacts from road construction have occurred to access timber, which may be located on forested wetland or on upland areas separated by wetland. Wetland impacts have also occurred when steep slopes are avoided for road construction; often construction of a road in a wetland is the environmentally preferred alternative to construction on a steep slope. For further information on wetland avoidance, see the Transportation section. Within the context of past project objectives, including economics and minimizing environmental harm, past road construction has avoided wetlands to the extent practicable in the project area.

## *Environmental Consequences*

The analysis area selected for direct, indirect, and cumulative effects of the project includes the entire project area. This boundary was selected because project effects on wetlands are primarily limited to the watershed of the effected wetlands and the project area generally follows watershed boundaries. An interdisciplinary project team has identified key indicators for measuring project effects on wetlands. These indicators are:

- Acres of wetland altered by road construction,
- Acres of harvest on forested wetlands, and
- Cumulative acres of wetland habitat harvested and removed from productivity by roads.

The effects of the Big Thorne Project on wetlands would be limited through the site-specific application of Forest Plan standards and guidelines as well as BMPs for all action alternatives. In particular, the LUD-specific measures identified in Chapter 3, the Forest-wide measures identified in the Wetlands section of Chapter 4 of the 2008 Forest Plan, and the baseline provisions included in the CWA, would be implemented.

All action alternatives propose some level of timber harvest on forested wetlands. The effects of timber harvest (primarily increased soil moisture levels) on forested wetlands are expected to be temporary. All harvested sites are expected to regenerate naturally.

Due to the preponderance of wetlands and the interspersed nature of wetlands with uplands on the project area, complete avoidance of wetlands from proposed road construction activities is not practicable. Most proposed roads would be constructed on forested wetlands and uplands. All estuaries are avoided by proposed roads in the action alternatives. All proposed roads will be constructed according to State-approved BMPs as required by 33 CFR 323. State-approved BMPs consist of those BMPs documented in FSH 2509.22 and documented on the road cards in the Big Thorne Project record. All roads through wetlands will also follow the 15 baseline provisions provided in 33 CFR 323 also documented on the road cards. Table WET-2 provides a summary of proposed timber harvest and road construction wetlands.

The four action alternatives avoid wetlands to the extent practicable. Site-specific wetland avoidance is documented on the road cards for NFS road segments and the unit cards for temporary road segments (unit cards and road cards are in Appendices B and C of the DEIS). At the project scale, 37 percent of all proposed roads, both NFS and temporary, are on wetlands in Alternative 2. In Alternatives 3, 4, and 5, a total of 26, 13, and 20 percent of the proposed NFS and temporary roads are on wetlands, respectively. Within all action alternatives, from 27 to 34 percent of the proposed harvest is on sites classified as forested wetlands. Access within and to these stands often requires crossing wetlands.

**Table WET-2.** Road and Timber Harvesting Impacts on Wetland Types by Action Alternative

| Impact Type | Wetland Type | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---|---|---|---|---|---|
| Road Construction[1/2/] (acres) | Moss Muskeg[4] | 2 | 2 | 0.1 | 1 |
| | Alpine Muskeg[4] | 1 | 1 | 0 | 0 |
| | Emergent Tall Sedge Fen[4/] | <0.1 | <0.1 | 0 | 0 |
| | Emergent Short Sedge Fen[4/] | 0.3 | 0.3 | 0 | 0 |
| | Forested /Emergent Short Sedge Complex | 8 | 9 | 0.3 | 1 |
| | Forested Wetland | 46 | 54 | 7 | 13 |
| | **Total Acres of Wetland Road Impact** | **57** | **66** | **7** | **14** |
| Timber Harvesting[3/4/] (acres) | Moss Muskeg[4/] | 24 | 32 | 15 | 25 |
| | Alpine Muskeg[4/] | 11 | 11 | 13 | 12 |
| | Emergent Tall Sedge Fen[4/] | 0 | 0 | 0 | 0 |
| | Emergent Short Sedge Fen[4/] | 10 | 17 | 16 | 18 |
| | Forested /Emergent Short Sedge Complex | 94 | 188 | 175 | 176 |
| | Forested Wetland | 1,728 | 2,658 | 1,810 | 2,174 |
| | **Total Acres of Harvested Wetland** | 1,867 | 2,906 | 2,029 | 2,406 |

1/ Road acreage calculated based on a 40-foot wide road disturbance area.
2/ Reconstruction of stored system roads through wetlands and construction over decommissioned road grades through wetlands are not included in the proposed road construction numbers, as these areas are included in acres of existing roads.
3/ Includes all harvest prescriptions, including partial harvest and young growth thinning.
4/ Acres of harvest on non-forested wetland are due to small inclusions of forest land within a wetland map unit that is typically non-forested, or small inclusions of non-forested wetland on the edges of or inside harvest units.

## Alternative 1 – No Action

### *Description of Alternative 1*

Alternative 1 is the No-action Alternative. In addition to being an alternative to the proposed action, it provides a baseline for evaluation of the impacts associated with the action alternatives. It would result in no timber harvest or road construction activities in wetlands as a result of the project.

### *Direct and Indirect Effects of Alternative 1*

No wetlands would be impacted under Alternative 1 due to harvest or road construction as a result of the Big Thorne Project. Vegetation on forested wetlands harvested in the past would continue to grow toward hydrologic maturity (many stands have already reached this stage). Wetlands impacted by roads in the past would continue to be impacted. Vegetation would occupy ditch lines and, in the case of closed roads the roadbed, may be occupied by red alder. The road prism would remain in an upland condition. Road ditches, where present, support a variety of upland and wetland vegetation depending on local conditions and seed sources. Hydrologic and vegetation effects would typically remain limited beyond the road prism (Glaser 1999; Kahklen and Moll 1999; McGee 2000).

### Effects Common to All Action Alternatives

Road construction and timber harvest are proposed in wetlands in all action alternatives. Effects common to all alternatives are summarized below and effects are discussed by alternative in the following subsections.

Road impacts, required to access timber, would result in a permanent loss of wetland acreage in all action alternatives. Acres of impacts from roads for each alternative are described in the following sections and summarized in Table WET-2. Acres of wetland loss due to road impacts generally correspond to the total miles of proposed road construction for each alternative.

#### *Effects from Road Building*

The effects of road building on wetlands may vary based on the substrate (soil type) and the landscape position of the wetland. Regardless of the type and location, road construction on wetlands results in an overall loss of wetland acreage.

Road construction on peatlands of the Tongass National Forest was studied and found to have little effect on wetland vegetation, hydrology, or water quality adjacent to the road (Glaser 1999). These wetland types are often located on ridge tops and relatively flat areas and the soils in these landscape positions are typically peat soils over bedrock. Changes to the plant community and hydrology were found to be limited to within a few meters of the road. This is theorized to be due to the high water-holding capacity of the soil and abundant local precipitation.

Roads crossing slope wetlands have a higher chance of disrupting the down-gradient flow of water, as water is intercepted by roadside ditches and potentially blocked by the road bed. The implementation of BMPs for road construction on wetlands in these landscape positions is necessary to prevent adverse hydrological impacts to wetlands located down-gradient of the road. While application of BMPs provides some assurance that surface water streams will not be diverted by roads, ground and surface water may be captured and diverted to the nearest stream or drainage-relief culvert. However, the high precipitation rates and soil moisture in Southeast Alaska appears to minimize the impacts of water that is intercepted by roadside ditches. A study in Southeast Alaska indicated that water level disruptions from road building quickly recover beyond the immediate road vicinity (McGee 2000). An additional study on the effects of roads on hydrology indicated that the effects range from between 5 and 10 meters on each side of the road prism (Kahklen and Moll 1999).

The Tongass National Forest has conducted implementation and effectiveness monitoring of wetland BMPs. This monitoring was conducted in 2006, 2008, and 2011. In 2011, new road construction and roads constructed more than 30 years ago were reviewed. The most recent 2011 monitoring assessment indicates that wetlands were avoided to the extent practicable while meeting project goals and objectives and impacts to wetlands were minimized. The 2011 monitoring displayed a high rate of implementation of the 15

Federal baseline provisions (Landwehr 2011a). The 2006 and 2008 monitoring showed similar results.

### *Effects from Timber Harvesting*

Forested wetlands cover 25 percent of the project area and are managed for their timber resources. As a result, the action alternatives would conduct harvest on 1,728 to 2,658 acres of forested wetlands, depending on the alternative.

The three widely accepted functions that wetlands provide are water quality maintenance, hydrologic functions, and wildlife habitat. Project effects of these functions are not exclusive to wetlands; wildlife habitat effects are analyzed in the Wildlife and Subsistence Resource Report (Woeck 2013a) and effects on water quality and watershed and sub-watershed hydrology can be found in the Watershed Resource Report (James 2013). Research regarding potential project effects on wetland soil hydrology and tree growth rates are described below.

Research has demonstrated that the water balance of coastal forests can be affected through timber harvest (Patric 1966; Beaudry and Sagar 1995; Banner et al. 2005; Julin and D'Amore 2003), leading to an increase in soil moisture and slower growth in seedlings and saplings. This effect is the result of removal of the forest canopy resulting in an increase in the amount of precipitation reaching the ground surface and lower evapotranspiration rates. Because the water table on the wettest forested wetlands is near the soil surface, additional soil moisture can negatively affect conifer establishment and tree growth. Timber harvest is proposed in wetlands in all action alternatives. Based on Julin and D'Amore (2003), harvest activities are expected to have a minimal and short-term effect on wetland soil moisture and tree growth. Removal of timber would lead to a short-term increase in soil saturation until young-growth establishes evapotranspiration surfaces similar to pre-harvest conditions. Effects on soil moisture will likely be less in areas where partial cutting is utilized rather than clearcutting. Also, effects on soil moisture will likely be less in areas where thinning is utilized as compared to clearcutting. The proposed harvest in all action alternatives would not pose a long-term negative impact to wetlands in the project area.

#### Alternative 2 – Direct and Indirect Effects

Alternative 2 proposes to harvest timber from approximately 1,728 acres of forested wetland (Table WET-2). An additional 139 acres mapped as wetland also occur within harvest units; these primarily represent forested wetland/emergent short sedge (94 acres), which can be up to 50 percent forested and mapped inclusions of non-forested wetlands (45 acres). Following harvest, trees growing on these wetlands would likely grow slower than trees on upland sites. Soil moisture would temporarily increase as described in Effects Common to All Action Alternatives. Approximately 77 percent of the harvested wetlands would be clearcut with the remaining having partial-harvest prescriptions. These partial-harvest areas would be expected to have smaller soil moisture increases, due to the lower proportion of trees harvested. Although this alternative would have the lowest overall amount of harvest on wetlands, this is due to the absence of young-growth thinning in this alternative. Alternative 2 would have the second-highest effect from harvesting on wetlands due to the amount of acreage clearcut.

Road construction under this alternative would result in conversion of wetland to road on approximately 46 acres of forested wetlands, 8 acres of forested wetland/ emergent short sedge, 2 acres of moss muskeg, less than ½ acre of emergent sedge fen, and 1 acre of alpine muskeg. The specific effects are described above. This alternative would have the second-highest amount of wetland affected by road construction.

Overall, this alternative would have the second-highest impact to wetlands, with 57 acres of wetland converted to road and the second-highest amount of clearcut forested wetland. This alternative would have lower impacts than Alternative 3, and greater impacts than Alternatives 4 and 5. Although the overall acreage of harvest on wetlands would be higher for all other alternatives, these impacts are temporary, and as noted above, the effects of partial harvest and thinning would be lower than clearcutting due to partial retention of the tree canopy. The effects due to road construction are more significant due to the resulting long term loss of wetland acreage. In comparison to the other alternatives due to road construction, Alternative 2 would alter 9 fewer acres than Alternative 3, would alter 50 more acres than Alternative 4, and would alter 42 more acres than Alternative 5.

**Alternative 3 – Direct and Indirect Effects**

Alternative 3 proposes to harvest timber from approximately 2,658 acres of forested wetland, 188 acres of forested wetland/ emergent short sedge, 32 acres of moss muskeg, 17 acres of emergent short sedge, and 11 acres of alpine muskeg. Following harvest, trees growing on these wetlands would likely grow slower than trees on upland sites. Soil moisture would temporarily increase as described in Effects Common to All Action Alternatives. Approximately 59 percent of the harvested forested wetlands would be clearcut, 25 percent would have partial-harvest prescriptions and 17 percent would be young-growth thinning. These partial-harvest and thinned areas would be expected to have smaller soil moisture increases, due to the lower proportion of trees harvested. This alternative would have the highest overall amounts of harvest on wetlands and the highest amount of clearcuts on wetlands. Alternative 3 would have the highest effect from harvesting on wetlands due to the amount of acreage clearcut.

Road construction under this alternative would result in conversion of wetland habitat to road on approximately 54 acres of forested wetlands, 9 acres of forested wetland/ emergent short sedge, 2 acres of moss muskeg, less than ½ acre of emergent sedge fen, and 1 acre of alpine muskeg. The specific effects are described above. This alternative would have the highest amount of wetland affected by road construction.

Overall, this alternative would have the highest impact to wetlands, with 66 acres of wetland altered due to road construction and the highest amount of clearcut forested wetland. In comparison to the other alternatives due to road construction, Alternative 3 would alter 9, 59, and 52 more acres of wetland than Alternatives 2, 4, and 5, respectively.

**Alternative 4 – Direct and Indirect Effects**

Alternative 4 proposes to harvest timber from approximately 1,810 acres of forested wetland, 175 acres of forested wetland/ emergent short sedge, 15 acres of moss muskeg, 16 acres of emergent short sedge, and 13 acres of alpine muskeg. Following harvest, trees growing on these wetlands would likely grow slower than trees on upland sites. Soil moisture would temporarily increase as described in Effects Common to All Action

Alternatives. Approximately 14 percent of the harvested wetlands would be clearcut, 64 percent would have partial-harvest prescriptions and 22 percent would be young-growth thinning. These partial-harvest and thinned areas would be expected to have smaller soil moisture increases, due to the lower proportion of trees harvested. This alternative would have the second-lowest overall amount of harvest on wetlands and the lowest overall effect from harvesting on wetlands due to the smallest amount of clearcutting and the large proportion of the harvest that is a partial harvest prescription or young-growth thinning.

Road construction under this alternative would result in conversion of wetland habitat to road on approximately 7 acres of forested wetlands, less than ½ acre of forested wetland/ emergent short sedge, and less than ½ acre of moss muskeg. The specific effects are described above. This alternative would have the lowest amount of wetland affected by road construction.

Overall, this alternative would have the lowest impact to wetlands, with 7 acres of wetland altered due to road construction and the lowest amount of clearcut forested wetland, as well as the second-lowest overall harvest on wetlands. In comparison to the other alternatives of road construction, Alternative 4 would alter 50, 59, and 7 fewer acres of wetland than Alternatives 2, 3, and 5, respectively.

#### Alternative 5 – Direct and Indirect Effects

Alternative 5 proposes to harvest timber from approximately 2,174 acres of forested wetland, 176 acres of forested wetland/ emergent short sedge, 25 acres of moss muskeg, 18 acres of emergent short sedge, and 12 acres of alpine muskeg. Following harvest, trees growing on these wetlands would likely grow slower than trees on upland sites. Soil moisture would temporarily increase as described in Effects Common to All Action Alternatives. Approximately 33 percent of the harvested wetlands would be clearcut, 49 percent would have partial-harvest prescriptions and 18 percent would be young-growth thinning. These partial-harvest and thinned areas would be expected to have soil moisture increases that are lower, due to the lower proportion of trees harvested. This alternative would have the second-lowest level of clearcutting on wetlands following Alternative 4.

Road construction under this alternative would result in conversion of wetland habitat to road on approximately 13 acres of forested wetlands, 1 acre of forested wetland/ emergent short sedge, and 1 acre of moss muskeg. This alternative would have the second-lowest amount of wetland affected by road construction.

Overall, this alternative would have the second-lowest impact to wetlands, with 14 acres of wetland altered due to road construction and the second-lowest amount of clearcut forested wetland. The effects due to road construction would be greater due to the resulting long-term loss of wetland acreage compared to the temporary effects resulting from harvesting on wetlands. In comparison to the other alternatives due to road construction, Alternative 5 would have 7 more acres of wetland altered than Alternative 4, and 42 and 52 fewer acres of wetland altered than Alternatives 2 and 3, respectively.

### Cumulative Effects

Because the effects of the past, present, and reasonably foreseeable actions are consistent across all alternatives, the cumulative effects are comparable by alternative. Table WET-3 indicates the estimated cumulative acres of tree harvesting and road effects on wetlands from past, present and foreseeable projects within the project area. Present and reasonably foreseeable projects are described in more detail at the beginning of Chapter 3.

#### *Alternative 1*

Approximately 13,884 acres of timber have been harvested from wetlands in the project area, including 10,077 acres of forested wetland, 2,740 acres of forested wetland/emergent sedge complex and 1,067 acres of non-forested wetland (Table WET-1). This equates to about 11 percent of the wetlands in the project area. On wetlands where timber has been harvested, vegetation would continue to grow toward hydrologic maturity, and overall soil moisture levels would return to pre-harvest conditions. Vegetation on the oldest harvest areas would be 30 to 60 years old and generally consist of vigorous young-growth stands, and soil moisture conditions should be returning to near pre-harvest conditions.

**Table WET-3.** Estimated Acres of Cumulative (Existing, Project, and Foreseeable) Wetland Impacts from Harvesting by Alternative

| Project Category | | Total Wetland Impacts Due to Harvesting (not including roads within harvest units) | | Total Wetland Impacts Due to Roads (all roads included) | |
|---|---|---|---|---|---|
| | | Acres | % of Total Wetlands in Project Area | Acres | % of Total Wetlands in Project Area |
| Past Projects | | **13,884** | **11%** | **1,113** | **0.9%** |
| Big Thorne Project | Alt. 1 | 0 | 0% | 0 | 0.0% |
| | Alt. 2 | 1,867 | 1.5% | 57 | <0.1% |
| | Alt. 3 | 2,906 | 2.3% | 66 | 0.1% |
| | Alt. 4 | 2,029 | 1.6% | 7 | <0.1% |
| | Alt. 5 | 2,406 | 1.9% | 14 | <0.1% |
| Reasonably Foreseeable Projects[1/] | | **37** | **<0.1%** | **<0.1** | **<0.1%** |
| Cumulative Projects[2/] | Alt. 1 | 13,921 | 10.9% | 1,113 | 0.9% |
| | Alt. 2 | 15,788 | 12.4% | 1,170 | 0.9% |
| | Alt. 3 | 16,828 | 13.2% | 1,179 | 0.9% |
| | Alt. 4 | 15,950 | 12.5% | 1,120 | 0.9% |
| | Alt. 5 | 16,328 | 12.8% | 1,127 | 0.9% |

1/ Impacts calculated assuming projects have a similar level of impact as the proposed action for the Big Thorne Project. Acres calculated based on projects described at beginning of Chapter 3 (Control Lake 351 acres, State Lands 635 acres, Free Use and Micro-sales 100 acres)

2/ Includes past projects, Big Thorne Project, and present/reasonably foreseeable projects.

About 691 acres of forested wetland, 301 acres of forested/emergent complex, and 120 acres of non-forested wetlands have been converted to road surfaces; ditches and fill slopes in the project area (see Table WET-1). Open, drivable roads on the project area would continue to receive incidental use by recreation visitors. Vegetation would grow in ditch lines on all roads, and on closed roads vegetation will likely colonize the road surfaces.

Contributions for current and reasonably foreseeable projects would have additional impacts, contributing approximately an additional 37 acres of harvesting on wetlands and less than a tenth of an acre of road impacts. Cumulatively, these reasonably foreseeable impacts would have little cumulative effect, resulting in less than a tenth of a percent of additional wetland effects by harvesting and roads (see Table WET-3). About 88 percent of wetlands in the project area would be in a natural condition. Of the wetland acreage affected, less than 7 percent would be due to cumulative road impacts by past and reasonably foreseeable projects.

### *Alternative 2*

Implementation of Alternative 2 would result in cumulative effects (existing, current and reasonably foreseeable, and Big Thorne) of approximately 15,788 acres of timber harvest from wetlands in the project area (outside of roads), including 11,825 acres of forested wetland, 2,841 acres of forested wetland/emergent sedge complex and 1,115 acres of non-forested wetland. This equates to about 12 percent of the wetlands on the project area (Table WET-3). This alternative would result in an increase of about 1 percent over the No-action Alternative and would have less cumulative effects on harvesting compared to all other action alternatives. However, because Alternatives 4 and 5 include substantial acreages of thinning and partial harvest and Alternative 2 includes more clearcutting than Alternatives 4 and 5 but less than Alternative 3, this alternative would have second-highest effects on wetlands due to timber harvesting. On wetlands where timber has been harvested, vegetation would continue to grow toward hydrologic maturity, and overall soil moisture levels would return to pre-harvest conditions. Vegetation on the oldest harvest areas is 30 to 60 years old and generally consists of vigorous second-growth stands, and soil moisture conditions should be returning to near pre-harvest conditions.

Implementation of Alternative 2 would result in cumulative impacts of about 1,170 acres of wetland converted to road surfaces, ditches and fill slopes in the project area (Table WET-3), consisting of 737 acres of forested wetland, 310 acres of forested/emergent complex, and 123 acres of non- forested wetlands. Open, drivable roads in the project area would continue to receive incidental use by recreation visitors. Vegetation would grow in ditch lines on all roads, and on closed roads vegetation will likely colonize the road surfaces. This alternative would result in the second-highest cumulative acres of wetland impacts due to roads (Table WET-3).

Under Alternative 2, about 87 percent of wetlands in the project area are would remain in a natural condition. This is 1 percent lower than Alternative 1, similar to Alternative 4, and 1 percent higher than Alternatives 3 and 5. Of the wetland acreage affected, about 7 percent would be due to cumulative road impacts.

### *Alternative 3*

Implementation of Alternative 3 would result in cumulative effects (existing, current and reasonably foreseeable, and Big Thorne) of approximately 16,828 acres of timber harvested from wetlands on the project area (outside of roads, Table WET-3), including 12,762 acres of forested wetland, 2,935 acres of forested wetland/emergent sedge complex and 1,130 acres of non-forested wetland. This equates to about 13 percent of the wetlands on the project area. This alternative would result in an increase of about 2 percent over the No-action Alternative and less than 1 percent over the remaining action alternatives. This alternative would have the highest cumulative effects from harvesting. On wetlands where timber has been harvested, vegetation would continue to grow toward hydrologic maturity, and overall soil moisture levels would return to pre-harvest conditions. Vegetation on the oldest harvest areas is 30 to 60 years old and generally consists of vigorous second-growth stands, and soil moisture conditions should be returning to near pre-harvest conditions.

Implementation of Alternative 3 would result in cumulative effects of about 1,179 acres of wetland converted to road surfaces, ditches and fill slopes in the project area (Table WET-3), consisting of 745 acres of forested wetland, 310 acres of forested/emergent complex, and 123 acres non-forested wetlands. Open, drivable roads in the project area would continue to receive incidental use by recreation visitors. Vegetation would grow in ditch lines on all roads, and on closed roads vegetation will likely colonize the road surfaces. This alternative would result in the highest cumulative acres of wetland effects due to roads (Table WET-3).

Under Alternative 3, about 86 percent of wetlands in the project area are would remain in a natural condition. This is 2 percent lower than Alternative 1, and less than 1 percent lower than the remaining action alternatives. Of the wetland acreage affected, about 7 percent would be due to road impacts.

### *Alternative 4*

Implementation of Alternative 4 would result in cumulative effects (existing, current and reasonably foreseeable, and Big Thorne) of approximately 15,950 acres of timber harvested from wetlands on the project area (Table WET-3), including 11,914 acres of forested wetland, 2,922 acres of forested wetland/emergent sedge complex and 1,115 acres of non-forested wetland. This equates to about 13 percent of the wetlands on the project area (Table WET-3). This alternative would result in an increase of about 2 percent over the No-action Alternative, less than a 1 percent increase over Alternative 2, and less than a 1 percent decrease over Alternatives 3 and 5. However, this alternative would have the lowest cumulative effects from harvesting due to the amount of harvest that would be partial cutting or thinning of young growth, as described in the Environmental Consequences section. On wetlands where timber has been harvested, vegetation would continue to grow toward hydrologic maturity, and overall soil moisture levels would return to pre-harvest conditions. Vegetation on the oldest harvest areas is 30 to 60 years old, and generally consists of vigorous second-growth stands, and soil moisture conditions should be returning to near pre-harvest conditions.

Implementation of Alternative 4 would result in cumulative effects of about 1,120 acres of wetland converted to road surfaces, ditches and fill slopes in the project area, consisting of 698 acres of forested wetland, 302 acres of forested/emergent complex, and 120 acres non forested wetlands. Open, drivable roads on the project area would continue to receive incidental use by recreation visitors. Vegetation would grow in ditch lines on all roads, and on closed roads vegetation will likely colonize the road surfaces. This alternative would result in the lowest cumulative acres of wetland effects due to roads (Table WET-3).

Under Alternative 4, about 87 percent of wetlands in the project area are would remain in a natural condition. This is 1 percent lower than Alternative 1, 1 percent higher than Alternatives 3 and 5, and similar to Alternative 2. Of the wetland acreage affected, about 7 percent would be due to road impacts.

*Alternative 5*

Implementation of Alternative 5 would result in cumulative effects (existing, current, and reasonably foreseeable, and Big Thorne) of approximately 16,328 of timber harvested from wetlands on the project area (outside of roads, Table WET-3), including 12,278 acres of forested wetland, 2,923 acres of forested wetland/emergent sedge complex and 1,126 acres of non-forested wetland. This equates to about 13 percent of the wetlands on the project area (Table WET-3). This alternative would result in an increase of about 2 percent over the No-action Alternative and less than 1 percent higher than Alternatives 2 and 4, and less than 1 percent lower than Alternative 3. However, this alternative would have the second-lowest cumulative effects from harvesting due to the emphasis on partial harvest and thinning. On wetlands where timber has been harvested, vegetation would continue to grow toward hydrologic maturity, and overall soil moisture levels would return to pre-harvest conditions. Vegetation on the oldest harvest areas is 30 to 60 years old, and generally consists of vigorous second-growth stands, and soil moisture conditions should be returning to near pre-harvest conditions.

Implementation of Alternative 5 would result in cumulative effects of about 1,127 acres of wetland converted to road surfaces, ditches, and fill slopes in the project area (Table WET-3), consisting of 704 acres of forested wetland, 302 acres of forested/emergent complex, and 121 acres non forested wetlands. Open, drivable roads on the project area would continue to receive incidental use by recreation visitors. Vegetation would grow in ditch lines on all roads, and on closed roads vegetation will likely colonize the road surfaces. This alternative would result in the second-lowest cumulative acres of wetland effects due to roads. Overall, the total cumulative increase due to roads is similar to the Alternatives 1 and 4, and lower than Alternatives 2 and 3 (Table WET-3).

Under Alternative 5, about 86 percent of wetlands in the project area are would remain in a natural condition. This is 2 percent lower than Alternative 1, 1 percent lower than Alternatives 2 and 4, and less than 1 percent higher than Alternative 3. Of the wetland acreage affected, about 6 percent would be due to road impacts.

# Botany

## Introduction

This section provides a summary of existing conditions and the direct, indirect, and cumulative effects on sensitive and rare plants in the Big Thorne project area. Only one species in Alaska, *Polystichum aleuticum* (C. Christen.), is listed as endangered. Its known range is restricted to Adak Island in the Aleutian Islands. No proposed or federally listed species are known on the Tongass National Forest. Full discussion of the botany resource is available in the Biological Evaluation for Plants (Opolka and Fairbanks 2013a) and the Botany Resource Report (Opolka 2013a) located in the Big Thorne Project record.

### Analysis Area

The analysis area for direct and indirect effects to sensitive and rare plants is the project area. The analysis area for cumulative effects to sensitive and rare plants considers Biogeographic Provinces 14 and 18, which includes all of Prince of Wales Island, plus some of the neighboring islands (see Land Division section at the beginning of Chapter 3). This area represents the most biologically and physiographically similar area and is geographically isolated. These provinces were used for cumulative effects analysis because many of the Sensitive and Rare plants have a range that extends beyond the project area and species viability must take other populations into consideration.

### Methods

#### *Field Surveys*

Prior to field surveys, a prefield review of the project area was conducted. This included review of aerial photographs, discussions with resource specialists, a review of previously documented species, and a review of GIS habitat data to determine habitat types present in the project area.

Focused intuitive surveys for Sensitive and Rare plants were conducted for the project. This survey type involves identifying suitable habitat for targeted species and then focusing the survey effort within those identified habitats. The field surveys were conducted in 2009, 2010, 2011, and 2012, at an appropriate time of year to identify targeted species. Field surveys included portions of 204 harvest units and covered approximately 6,616 acres within the project area (3 percent of the entire project area), including 2,322 acres in the unit pool area and 14.5 miles of proposed roads. Surveys were also conducted outside of harvest units and in non-development LUDs, which aided in the cumulative effects analysis for alternative comparisons. Multiple populations of sensitive and rare plant species were identified as a result of field surveys for this project. Based on field surveys, the spatial extent of each population was mapped and digitized and a plant count or estimate was made for each. Additional field surveys were completed in 2011 and 2012 and results have been incorporated into the Final EIS. Additional details of the prefield review and field survey can be found in the Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record.

*Habitat Suitability Models*

General habitat suitability models have been developed for several sensitive and one rare plant species on the Tongass National Forest, including two of the species found in a number of locations in the project area: whiteflower rein orchid (*Piperia candida*) and lesser round-leaved orchid (*Platanthera orbiculata*; USDA Forest Service 2011g). Use of the models for analysis of effects was based on guidance outlined in the habitat suitability model report (USDA Forest Service 2011g). The primary use of the models was to estimate the percentage of potentially suitable habitat affected by alternative relative to the total suitable habitat within the project area and the cumulative effects analysis area. These models are considered only a tool for identifying *potential* suitable habitat; they do not provide accurate information on the actual distribution of sensitive plants, but can be used in a relative sense for comparisons. Therefore, the models need to be used in combination with other information, including professional expertise and field survey data, to make determinations of risk regarding project effects on these species.

*GIS Analyses*

GIS layers were created for known sensitive and rare plant populations (with plant count information) and survey areas. Using this information, effects on populations and individuals were estimated. A direct effect to a population was recorded if part of a sensitive plant population polygon overlapped with a road, landing, or harvest area. An indirect effect to a sensitive or rare plant population was recorded if any of the activities causing a direct effect were located within 50 meters of a plant polygon. The number of individuals directly or indirectly affected was estimated by adjusting the plant count for each polygon based on the proportion of the polygon area affected.

## Affected Environment

### Sensitive Plants

There are 17 plant species and 1 lichen that have been designated as Sensitive on the Alaska Regional Forester’s list; 16 of these are known or suspected to occur on the Tongass National Forest. Four of these species have been documented on the Thorne Bay Ranger District; 2 of these have been documented in the project area. The Thorne Bay Ranger District is within the potential range of an additional 6 species, which are suspected to occur on the District. Table BOT-1 summarizes the general habitat requirements of the 10 plant species that are either known to occur or suspected to occur on the Thorne Bay Ranger District.

**Table BOT-1**. Known or Suspected Sensitive Plants in the Thorne Bay Ranger District

| Scientific Name | Common Name | Presence[1/] | Habitat |
|---|---|---|---|
| *Botrychium spathulatum* | Spatulate moonwort | Suspected | Lightly vegetated coastal dunes and meadows and alpine slopes |
| *Botrychium tunux* | Moosewort fern | Suspected | Lightly vegetated coastal beaches and alpine scree |
| *Cypripedium parviflorum* var. *pubescens* | Large yellow lady's slipper orchid | Known | Peatlands, occasionally on limestone substrates, open forested habitats |
| *Ligusticum calderi* | Calder's loveage | Suspected | Subalpine meadows, occasionally of calcareous origin, perhaps in glacial refugia; forest edges; muskegs and fens |
| *Lobaria amplissima* | none | Known | Coastal areas on the forest fringe, often on the water-side of tree boles and large limbs |
| *Piperia unalascensis* | Alaska rein orchid | Suspected | Forested areas, edges between forest and muskeg |
| *Platanthera orbiculata* | Lesser round-leaved orchid | Known | A variety of habitats, most commonly in forested habitats and along the forested muskeg edge. Found in both old and young growth. |
| *Romanzoffia unalaschcensis* | Unalaska mist-maid | Known | Coarse substrates including stream side gravelly areas, rock outcrops and crevices, and coastal areas |
| *Sidalcea hendersonii* | Henderson's checkermallow | Suspected | Coastal areas in the zone between estuary and forest |
| *Tanacetum bipinnatum* | Dune tansy | Suspected | Sandy soils in coastal areas |

1/ Known=known to occur in the Thorne Bay Ranger District.
Suspected=suspected to occur in the Thorne Bay Ranger District

One sensitive species was found with some regularity during project field surveys; the lesser round-leaved orchid. Surveys located 120 populations in the project area.

Lesser Round-leaved Orchid: The lesser round-leaved orchid was observed at numerous locations during field surveys for the Big Thorne Project. A total of 120 populations of this species were mapped, containing an estimated 4,019 individuals, which represents about 73 percent of the known individuals on the Tongass National Forest. The majority of known populations in the project area are concentrated along the Thorne Bay to Control Lake highway, in the lower North Thorne River drainage, west of Sandy Beach, and north of Luck Lake.

This plant is typically found in old growth, mostly in productive old growth, but commonly in unproductive old growth. Approximately 51 percent of the area occupied by mapped populations in the project area (weighted by plant counts) is located in productive old growth; 35 percent is located in unproductive old growth.

Although it is mostly found in old growth, the plant is occasionally found in older young-growth stands and disturbed habitats. Over 120 individual plants are located in young growth in the project area and approximately 5 percent of mapped populations were located entirely in young growth. It is unknown if these plants survived the initial harvest, became established subsequent to harvest, or if they were more or less abundant prior to the original harvest. Due to the unknowns regarding the tolerance of this plant to past harvest and its distribution in young growth, the effects of harvest on this plant are not clearly understood. Some plants may be damaged or killed during harvesting; however, plants growing in young growth have either survived or repopulated the area sometime after harvest.

### Rare Plants

Rare plant species known or suspected to occur on the Tongass National Forest are evaluated based on a list derived from the Alaska Natural Heritage Program (ANHP; USDA Forest Service 2009d). Included are species with a State Ranking[2] of S1, S2, or occasionally S3, excluding species that are already listed as Sensitive on the Tongass National Forest. Additional plants have been evaluated for this project because they are known to be rare, but do not yet have a State ranking by the ANHP. The list may change with plants added or dropped as additional information on plant distribution and taxonomy is learned.

Several rare plants were found during surveys within the Big Thorne project area, including western meadowrue (*Thalictrum occidentale*), northern moonwort (*Botrychium pinnatum*), whiteflower rein orchid (*Piperia candida*), seaside bittercress (*Cardamine angulata*), and lance leaf grapefern (*Botrychium lanceolatum*). Western meadowrue was found at 15 locations, almost entirely on stream banks and lake shores. Northern moonwort was found at two locations near Rio Roberts Creek, in a timbered area, and along the edges of an old road below the right-of-way. Whiteflower rein orchid was found at 30 locations in the project area. The seaside bittercress is known along the right-of-way of the state highway, near Big Salt in the southwestern corner of the project area, on private land. The lance-leaf grapefern was found at one location, in forest habitat near Luck Lake.

## *Environmental Consequences*

### General Description of Effects

The project has the potential to have direct, indirect, and cumulative effects on rare and sensitive plant species. Direct effects are those that would occur immediately or soon after the implementation of the action. Indirect effects are those effects that are may occur at a later point in time after the project has been implemented. Cumulative effects are those that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of the source of the action.

Direct effects of the project may include the following:

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[2] Rank S1 indicates a plant is critically imperiled and extremely rare in the State of Alaska.
Rank S2 indicates that within the State of Alaska the status of this species is imperiled due to rarity (between 6 and 20 occurrences) or some other concern.
Rank S3 indicates the plant is rare or uncommon (21-100 occurrences) in the State of Alaska.

- *Physical Damage*—Plants may be destroyed or damaged through crushing by logging equipment and activities associated with tree felling and yarding. Road building would completely bury or remove plants or entire populations if they were located in the road bed and could also damage plants or populations of plants that are located along the perimeter of the road embankment.

Indirect effects of the project may include the following:

- *Hydrology*—Road building can alter the hydrology, as surface and ground water may be redirected and channelized by roadside ditches, altering the hydrologic regime. Increased water levels may result in the death or decline in vigor of plants not adapted to a high water table. Conversely, plants adapted to wetland conditions may become desiccated by a decrease in water availability. Removal of the tree canopy results in changes in light, temperature and soil moisture (Heithecker and Halpern 2007), potentially beyond the tolerance levels of some species. BMPs will be implemented that will limit alterations to hydrology (see Watershed Resource Report [James 2013]).
- *Light Levels*—Partial or complete removal of the tree canopy results in an increase in the light levels in the understory, potentially resulting in light levels beyond the tolerance for shade dependent species. Once the stand regenerates, light levels will decrease with increasing canopy cover due to high density of small conifers. This too may alter normal light requirements for many species, including Sensitive and Rare plants.
- *Invasive Species*—Increased light levels associated with tree harvesting, expansion of the road network, and ground-disturbing activities can result in the introduction and/or spread of invasive species. Invasive species can out-compete native species and colonize preferred habitat. If the recommended mitigation measures and monitoring for invasive species are implemented, the effects to rare and sensitive plants as a result of invasive species should be very limited.

The indirect effects distance used for analysis was based on past research on the edge effect changes to microclimate, changes in understory vascular plants in mature or old-growth forest in response to adjacent clearcutting, the temporal edge effects, and the tolerance to edge habitat of the species of concern. Changes to microclimate can be observed up to 200 meters or more into adjacent unharvested stands (Concannon 1995; Chen 1993, 1995), although the long-term effects on understory vegetation are less clear. At least in the short term (less than 5 years post-harvest), the research indicates that changes are either not apparent or limited to within 10 meters of the edge (Concannon 1995; Heithecker and Halpern 2007). Known locations for sensitive and rare plants in the project area were also evaluated, based on their known occurrences and apparent tolerance for edge habitat. Based on all available information, a distance of 50 meters was used as the outer limits for indirect effects, with consideration given to the gaps in research, potential unknowns with regards to habitat requirements, and changes that may occur over the course of decades. The indirect effects addressed here are much less likely to occur than direct effects and, if they do occur, would generally be lower in intensity. Furthermore, the indirect effect zone used here represents a decreasing gradient of potential effects ranging from the edge of the direct effects zone out 50 meters.

Additional details of these studies and the distribution of existing plant populations with respect to edge environments are included in the Biological Evaluation for Plants and Botany Resource Report (Opolka and Fairbanks 2013a, Opolka 2013a), which are in the Big Thorne Project record.

Cumulative effects are the sum of the direct and indirect effects from the Big Thorne Project plus other projects that have occurred in the past, are presently occurring, or are expected to occur in the foreseeable future. Individually these effects may be minor, but together can result in cumulative effects over time. The analysis area for cumulative effects is explained previously under the Analysis Area section.

The direct, indirect, and cumulative effects of the project are used to determine the risk of the project on sensitive species that may potentially be affected by the project. This is conducted through a risk assessment, included in the Biological Evaluation for Plants (Opolka and Fairbanks 2013a).

## Avoidance and Minimization Measures

Through project design, efforts to avoid and minimize impacts on sensitive plants have been taken to prevent or reduce effects to known populations of sensitive and rare plants. These measures were conducted to ensure viability of sensitive and rare plants in the project area. Following is a summary of these measures.

- The only species with direct effects is widely distributed in the project area. Those with fewer populations or only one population were avoided under all alternatives.
- Where sensitive plants were widely distributed, proposed effects were not always avoidable. To minimize effects to individuals and the species the geographic extent of the population was considered. For example, for lesser round-leaved orchid, all alternatives directly affect individuals. However, these effects, for all alternatives, preserved the geographic extent of plant distribution in the project area. Populations near the geographic extent of the species distribution, and isolated populations were avoided under all alternatives.
- Population size and vigor was considered for populations that may be affected. Where populations were affected, they were generally small, with few individuals present or had poor habitat quality, such as at the edge of blowdown where additional blowdown was likely to occur.
- Where larger populations were affected, this was generally only done when there were large, extensive populations located nearby.
- Easily avoided populations, such as those on the edge of a stream buffer or along a unit edge were avoided.
- Legacy forest structure placement considered sensitive plants; when possible these legacy areas were designed to include sensitive plant populations.
- Appendix D in the Botany Resource Report (Opolka 2013a) and the unit cards (found in the project record) summarize every unit that has sensitive or rare plants in or near the unit. Proposed effects are explained with a summary that may

include relevant considerations such as the geographic species distribution, population size and vigor, and occurrence frequency in the project area.

## Effects by Alternative

### *Alternative 1 – No Action Alternative*

#### Direct, Indirect, and Cumulative Effects

For all the assessed species, Alternative 1, the No-action Alternative would not result in direct or indirect effects on Sensitive or Rare plant populations or their habitats as a result of the Big Thorne Project. As a result, there would be no incremental cumulative effects associated with the Big Thorne Project. Past timber harvest, road construction, and other activities have resulted in some impacts to the habitats of these assessed species. Reasonably foreseeable projects would not substantially contribute to cumulative effects.

### *Alternatives 2, 3, 4, and 5*

#### Spatulate Moonwort (Sensitive Species)

In Southeast Alaska, spatulate moonwort is known to grow on maritime sand dunes (USDA Forest Service 2009d). There are only two known populations in Alaska, on Chichagof Island and Kruzof Island (USDA Forest Service 2009d). Spatulate moonwort is suspected to occur in the Thorne Bay Ranger District although there are no known occurrences.

*Direct and Indirect Effects*

The project would not affect known populations or habitat of spatulate moonwort. The habitat in which this plant is predominantly known to grow would not be affected by the project. No timber harvest is proposed within 1,000 feet of the beach/estuary with this project. Direct and indirect effects to this plant are not anticipated by any of the project alternatives.

*Cumulative Effects*

None of the action alternatives would result in direct or indirect effects to known populations of this plant or its suitable habitat. In addition, reasonably foreseeable projects would not substantially contribute to effects on this species. Consequently, the project would not contribute to cumulative effects on this plant.

*Determination*

The overall determination of effect for this species is no impact. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

#### Moosewort Fern (Sensitive Species)

In Alaska, moosewort fern is known to grow on sandy beaches in the upper meadow zone and in alpine areas (USDA Forest Service 2009d). Moosewort fern is suspected to occur in the Thorne Bay Ranger District although there are no known occurrences.

*Direct and Indirect Effects*

The project would not affect known populations or habitat of moosewort fern. The habitat in which this plant is predominantly known to grow, such as lightly vegetated coastal beaches and alpine scree, would not be affected by the project. No timber harvest is proposed within 1,000 feet of the beach/estuary with this project.  Direct and indirect effects to this plant are not anticipated by any of the project alternatives.

*Cumulative Effects*
None of the action alternatives would result in direct or indirect effects to known populations of this plant or its suitable habitat.  In addition, reasonably foreseeable projects would not substantially contribute to effects on this species.  Consequently, the project would not contribute to cumulative effects to this plant.

*Determination*
The overall determination of effect for this species is no impact.  See the project Biological Evaluation for plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Dune Tansy (Sensitive Species)

Dune tansy grows in well-drained, sandy soils in coastal areas (USDA Forest Service 2009d).  Dune tansy is suspected to occur in the Thorne Bay Ranger District, although there are no known populations.

*Direct and Indirect Effects*
The project would not affect known populations or habitat of dune tansy.  No timber harvest is proposed within 1,000 feet of the beach/estuary with this project.  Direct and indirect effects to this plant are not anticipated by any of the project alternatives.

*Cumulative Effects*
None of the action alternatives would result in direct or indirect effects to known populations of this plant or its suitable habitat.  In addition, reasonably foreseeable projects would not substantially contribute to effects on this species.  Consequently, the project would not contribute to cumulative effects to this plant.

*Determination*
The overall determination of effect for this species is no impact.  See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Henderson’s Checkermallow (Sensitive Species)

Henderson’s checkermallow grows in coastal areas in the zone between the estuary and forest.  It is suspected to occur in the Thorne Bay Ranger District, although there are no known occurrences.

*Direct and Indirect Effects*
The project would not affect known populations or habitat of Henderson’s checkermallow.  No timber harvest is proposed within 1,000 feet of the beach/estuary with this project.  Direct and indirect effects to this plant are not anticipated by any of the project alternatives.

*Cumulative Effects*
None of the action alternatives would result in direct or indirect effects to known populations of this plant or its suitable habitat.  In addition, reasonably foreseeable projects would not substantially contribute to effects on this species.  Consequently, the project would not contribute to cumulative effects to this plant.

### *Determination*

The overall determination of effect for this species is no impact. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

## Calder's Loveage (Sensitive Species)

Calder's loveage inhabits forest edges, wetlands, and subalpine meadows, occasionally of calcareous origin in areas that may have been spared from glaciation during the last ice age (USDA Forest Service 2009d). It is documented on Prince of Wales Island and is suspected to occur in the Thorne Bay Ranger District (USDA Forest Service 2009d), although there are no known occurrences.

### *Direct and Indirect Effects*

The project would have no effects to known populations of Calder's loveage. This plant is not known to occur in the project area, although potential habitat is present. The project could potentially affect undetected individuals and habitat through road building activities, which could occur in wetland habitat. Individuals growing along forested edges could also be affected. Direct effects could occur through damage by machinery and placement of fill material during road building or harvesting. Indirect effects are also possible, potentially occurring as a result of soil moisture changes due to road building activities and windthrow or changes in cover due to harvesting. However, the overall risk to Calder's loveage as a result of this project is low.

### *Cumulative Effects*

None of the action alternatives would result in direct or indirect effects to known populations of this plant, although there could be cumulative effects to undetected individuals due to past, present, and future construction of roads in this plant's habitat. All action alternatives would result in road construction through wetlands (see Wetlands section), with the greatest potential effects caused by Alternative 3, followed by Alternatives 2, 5, and 4. However, the amount of cumulative road mileage on wetlands represents only a very small percentage of the overall wetland habitat in the analysis area. Road development in wetlands is avoided where practical, because of higher development costs and regulatory (CWA) requirements. Another potential cumulative risk factor for this species in Biogeographic Provinces 14 and 18 is potential mining activity at the south end of Prince of Wales Island, especially near Bokan Mountain, which has a number of known locations for this species. However, no known direct effects from mineral exploration activities have occurred to date. The overall risk to Calder's loveage as a result of this project is low due to a lack of effects to known populations and because it commonly occurs in habitats where management activities are unlikely to occur or limited.

### *Determination*

The overall determination of effect for this species is the project may adversely impact individuals, but is not likely to result in a loss of viability in the Tongass National Forest, nor cause a trend toward Federal listing. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Alaska Rein Orchid (Sensitive Species)

Alaska rein orchid inhabits forested areas, mesic meadows, and forest edges (USDA Forest Service 2009d). This plant has been previously misidentified across Southeast Alaska, and suspected populations within the Big Thorne Project area have recently been verified as whiteflower rein orchid (*Piperia candida*), and not Alaska rein orchid. Although there are no known occurrences on the Thorne Bay Ranger District, the Alaska rein orchid is suspected to occur.

#### *Direct and Indirect Effects*

The Big Thorne Project would have no effects on known populations of Alaska rein orchid. This plant is not known to occur in the project area, although potential habitat is present. The project could affect undetected individuals and habitat through timber harvest and road building activities. Direct effects could occur through damage by machinery and placement of fill during road building and timber harvest. Indirect effects are also possible, potentially occurring as a result of soil moisture changes and changes in available light. Given the known suitable habitat, Alternative 3 would have the greatest potential effects, and Alternative 4 would have the least. Considering the surveys completed and habitat targeted with no known occurrences found, the risk of this project having direct and indirect effects on Alaska rein orchid is low.

#### *Cumulative Effects*

None of the action alternatives would result in direct or indirect effects to known populations of this plant, and therefore this project would not contribute to cumulative effects to any known Alaska rein orchid populations. Cumulative effects to undetected individuals and suitable habitat due to past, present, and reasonably foreseeable timber harvest and road building may be possible. The overall risk of this project contributing to the cumulative effects is low, due to the lack of effects to known populations and the available potentially suitable habitat within the analysis area.

#### *Determination*

The overall determination of effect for this species is the project may adversely impact individuals, but is not likely to result in a loss of viability in the Tongass National Forest, nor cause a trend toward Federal listing. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Lobaria Amplissima (Sensitive Species)

*Lobaria amplissima* grows on the trunks and large branches of living trees and has been found on several different tree species where it grows at the beach fringe (USDA Forest Service 2009d). *L. amplissima* has been documented on the Thorne Bay Ranger District (USDA Forest Service 2009d) and four populations, containing 25 individual patches, were identified in the project area.

#### *Direct and Indirect Effects*

The project would have no direct effects to known populations or habitat of *Lobaria amplissima*. No timber harvest is proposed within 1,000 feet of the beach/estuary with this project. This lichen usually grows on trees facing the ocean, and the majority of dust would be “filtered” by existing trees and vegetation. Further, due to the amount of precipitation in Southeast Alaska, the number of days that dust would be present is limited.

Project-related dust may indirectly affect one known population located close to a main haul road. To minimize effects on a population located near existing NFS road 300000 (the Sandy Beach Road) at milepost 24.8, it is recommended that consideration be given to using the provision of the contract clause for the application of water to the road surface within 300 feet of this population to reduce dust, if the amount of dust is expected to increase with the use of the road for a particular contract. Frequency of water application would be dependent on the road use intensity and weather conditions.

#### *Cumulative Effects*

Cumulative effects due to past, present and reasonably foreseeable projects are possible. Past timber harvest and road construction on non-NFS lands or on NFS lands, that occurred prior to Forest Plan beach buffer standards and guidelines, may have impacted this lichen due to the harvesting of trees that it grows on. Cumulative effects due to present or future timber harvesting projects on NFS lands are expected to be minimal due to the beach buffer requirements, and minimal amount of non-NFS land within highly probable habitat for this species within the analysis area. Cumulative effects due to past, present, and future recreational use of the beach and firewood cutting may affect this lichen. Two of the known locations in the project area are located on trees in areas that are being used recreationally, which may impact survival of the lichens at these locations. There are 12 populations known in the cumulative effects analysis area. Of those 12, only 4 are in areas that would be likely to receive any recreational use. The others are along remote stretches of beach, including 3 populations within Old-Growth Habitat LUDs, and 3 within the South Prince of Wales Wilderness. Overall risk to this species as a result of the project is very low.

#### *Determination*

The overall determination of effect for this species is the project may adversely impact individuals, but is not likely to result in a loss of viability in the Tongass National Forest, nor cause a trend toward Federal listing. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Unalaska Mist-Maid (Sensitive Species)

There are three known occurrences of this plant in Southeast Alaska, with one of these occurrences located on the Tongass National Forest, on nearby Heceta Island. Unalaska mist-maid grows in gravelly substrates in a variety of locations, from streams to rock outcrops (USDA Forest Service 2009d), and on Heceta Island it is found on high-elevation limestone. This plant is not known to occur in the project area.

#### *Direct and Indirect Effects*

The project would have no effects on known populations of Unalaska mist-maid. The project could potentially directly affect undetected individuals and habitat through road building activities. Direct effects could occur through damage by machinery and placement of fill material during road building. Indirect effects are also possible, potentially occurring as a result of soil moisture changes due to road building or timber harvest. The risk of adverse effects to this plant is low, as minimal impacts to its habitat are likely to result from the project, and would primarily result from stream crossings. Potential effects to undetected individuals would be greatest among Alternative 3, which has the most road building and stream crossings, followed by Alternatives 2, 5, and 4, in that order.

*Cumulative Effects*

Cumulative effects to Unalaska mist-maid due to past, present, and reasonably foreseeable projects are possible. Past projects, primarily those involving road building, may have impacted undetected individuals or habitat in biogeographic provinces 14 and 18. Similarly, current or future projects (described in Chapter 3) that involve road building, including the Big Thorne Project, could affect undetected individuals or habitat. The potential for cumulative effects as a result of the project would be the highest from Alternative 3, which has the most road building and stream crossings, followed by Alternatives 2, 5, and 4, in that order. Overall risk to this plant as a result of the project is low, due to a lack of effects to known populations and the limited activities expected to occur in its habitat.

*Determination*

The overall determination of effect for this species is the project may adversely impact individuals, but is not likely to result in a loss of viability in the Tongass National Forest, nor cause a trend toward Federal listing. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Large Yellow Lady's Slipper (Sensitive Species)

The large yellow lady's slipper is typically found in peatlands and is known to occur in the Thorne Bay Ranger District, although the known locations are not in the project area.

*Direct and Indirect Effects*

The project would have no effects to known populations of large yellow lady's slipper. The project could potentially directly affect undetected individuals and habitat through road building activities in this plant's known habitat (primarily peatlands) and timber harvest in open forest habitats. Direct effects could occur through damage by machinery and placement of fill material during road building and timber harvest in open forest habitats. Indirect effects are also possible, potentially occurring as a result of soil moisture changes as a result of road building activities. The risk of adverse effects to this plant is low, as minimal impacts to its habitat are likely to result from the project. Potential effects to undetected individuals and habitat would be greatest among Alternative 3, which has the most road building, followed by Alternatives 2, 5, and 4.

*Cumulative Effects*

Cumulative effects to this plant due to past, present, and reasonably foreseeable projects are possible. Past projects, primarily those involving road building, may have impacted undetected individuals or habitat in biogeographic provinces 14 and 18. Similarly, current or future projects (described in Chapter 3) that involve road building and timber harvest in open forest habitats, including the Big Thorne project, could affect undetected individuals or habitat and timber harvest in open forest habitats. Given the location of the two known populations within the analysis area, road maintenance could affect existing plants located near roads. The potential for cumulative effects as a result of the project would be highest with Alternative 3, which has the most road building and timber harvest, followed by Alternatives 2, 5, and 4, in that order. The overall risk to this plant as a result of this project is low due to a lack of effects to known populations and because it commonly occurs in habitats where management activities are unlikely to occur or would be limited.

*Determination*

The overall determination of effect for this species is the project may adversely impact individuals, but is not likely to result in a loss of viability in the Tongass National Forest, nor cause a trend toward Federal listing. See the project Biological Evaluation for Plants (Opolka and Fairbanks 2013a) in the Big Thorne Project record for further information.

### Northern Moonwort (Rare species)

Northern moonwort is a rare plant that has been found at two locations near Rio Roberts Creek within the Big Thorne project area. Its habitat includes upper beach meadows, other meadows, forests, and streambanks.

*Direct and Indirect Effects*

Neither of the populations found in the project area are within the direct or indirect effect areas for Big Thorne Project activities; therefore, no direct or indirect effects would occur unless undetected individuals are affected.

*Cumulative Effects*

The only known populations of northern moonwort within the analysis area are the populations near Rio Roberts Creek. It is possible that undetected individuals and forested habitats have been affected by past, present and reasonably foreseeable timber harvest and associated activities. However, throughout the northern moonwort’s range, it is more commonly found in grassy sites and meadows, where management activities are generally limited. Other activities (e.g., trail and road construction) could have an impact on undetected individuals and habitat. Within biogeographic provinces 14 and 18, the overall risk to this plant is low to moderate, due to the lack of effects on known populations, and the effects to habitat.

### Seaside Bittercress (Rare species)

Seaside bittercress is a rare plant that has been found at one location in the Big Thorne project area, within the State Highway right-of-way near Big Salt on private land. Its habitat includes streambanks and moist forest, typically within riparian areas.

*Direct and Indirect Effects*

The only known population in the project area would not be directly or indirectly affected by Big Thorne Project activities; therefore, no direct or indirect effects would occur unless undetected individuals are affected.

*Cumulative Effects*

Throughout the analysis area, seaside bittercress has most commonly been found along larger fish-bearing streams and within forested riparian areas. There are also several documented populations within the beach fringe. The population within the project area is the furthest north documented population within the analysis area. Given the habitat where the plant has typically been found, it is generally protected on NFS lands from timber harvest by Forest Plan standards and guidelines. While few surveys have been completed on non-NFS lands for this plant, the buffer requirements established by the Alaska Forest Practices Act will likely provide protection for this species. Considering the generally protected habitat, the growth characteristics for this species, and the single known population in the project area, the overall risk of impacts to this species as a result of the Big Thorne Project is very low.

### Lance Leaf Grapefern (Rare Species)

One population of three individuals is present in the project area in forested habitat.

#### *Direct and Indirect Effects*

None of the action alternatives would result in any direct effects to known populations of lance leaf grapefern. In Alternatives 2, 3, and 5, a portion of the known population is within the indirect effects analysis area. Given the known habitat for lance leaf grapefern, the potential effects to undetected individuals and habitat would be greatest among Alternative 3, which has the most harvesting, followed by Alternatives 5, 2, and 4.

#### *Cumulative Effects*

There are three known populations of lance leaf grapefern in the analysis area. The other two populations are within non-development LUDs. Cumulative effects on this plant could occur to undetected individuals in forested habitat, primarily through timber harvesting. Past projects, including those that involve road building or timber harvesting, may have impacted undetected individuals or habitat in the project area. Similarly, current or future projects (described in Chapter 3) that involve these activities, including the Big Thorne Project, could affect undetected individuals or habitat. The potential for cumulative effects as a result of the project would be highest from Alternative 3, which has the most harvesting, followed by Alternatives 5, 2, and 4, in that order. The overall risk to this plant in the cumulative effects analysis area as a result of this project is moderate or less due to a lack of effects on known populations and potentially suitable habitat.

### Western Meadowrue (Rare species)

Western meadowrue is typically found along lakeshores and stream banks. In the project area, it was typically found along larger, fish-bearing streams and 15 populations of almost 3,000 plants have been located. Most populations and individuals are located in OGRs.

#### *Direct and Indirect Effects*

None of the action alternatives would result in any direct or indirect effects to known populations of western meadowrue. In the Draft EIS, there were two helicopter units under Alternative 3 (Units 420 and 439) that could have indirectly affected portions of two known populations of this plant. However, the portions of these two units within the indirect effects zone have since been dropped and no known direct or indirect effects would occur. The project could potentially directly affect undetected individuals and habitat through road-building activities. The risk of adverse effects to this plant is low, as minimal impacts to its habitat are likely to result from the project, and would primarily result from stream crossings. Potential effects to undetected individuals would be greatest with Alternative 3, which has the most road building and stream crossings, followed by Alternatives 2, 5, and 4, in that order.

#### *Cumulative Effects*

This plant is commonly found along larger fish-bearing streams and lakes, which are generally protected by buffers under the current forest plan; the Alaska Forest Practices Act also requires buffers for certain types of streams and lakes, depending on the presence of anadromous fish or whether it is a high quality resident fish water body, as well as the landownership. Prior to these buffers being required, past projects likely did affect this plant and its habitat. Current or future projects that involve road building, including the Big Thorne Project, could affect undetected individuals or habitat. The potential for cumulative effects as a result of the project would be the highest under Alternative 3, which has the most road building and stream crossings (and potential indirect effects), followed by Alternatives 2, 5, and 4, in that order. The overall risk to this plant in the cumulative effects analysis area as a result of this project is low due to the absence of direct effects to known populations and because it commonly occurs in habitats (stream and lake buffers) where management activities are unlikely to occur or would be limited.

### Whiteflower Rein Orchid (Rare Species)

Whiteflower rein orchid has been documented on the Tongass National Forest within 45 distinct populations comprising a total of 1,479 individual plants. In the Big Thorne project area 30 distinct populations comprising approximately 1,319 individuals have been documented. Therefore, the Big Thorne project area comprises 67 percent of the known populations within the Tongass National Forest which represents 89 percent of the known individuals.

The majority of the populations in the project area are concentrated along the Thorne Bay to Control Lake highway, in the North Thorne River drainage, west of Sandy Beach, and north of Luck Lake. These plants typically are found at the edge of muskeg and old-growth forest, although they also occur in forest interiors and along road edges. In the project area, some of the largest populations were found along roads and in ditches. Approximately 19 percent of the individual plants in the project area are located in productive old growth, 8 percent is in young growth, and 73 percent is located in non-forest and unproductive old growth. Given the rarity of whiteflower rein orchid throughout its known range, and recent verification within the State of Alaska, this species was treated similar to a sensitive species when developing the unit design criteria and avoidance measures for the alternatives.

Survey efforts covered approximately 6,600 acres within the project area, including over 2,300 acres within the unit pool. Well over 2,500 acres of the total survey area in the project area (including almost 1,000 acres of the surveys within the unit pool) were considered potential suitable habitat in the project area (based on generalized habitat modeling). This translates to approximately 38 percent of the potential suitable habitat surveyed.

#### *Direct and Indirect Effects*

Effects to the whiteflower rein orchid as a result of the Big Thorne Project are summarized by alternative in Table BOT-2. All alternatives avoid direct effects to known whiteflower rein orchid plants. Avoidance and minimization measures were previously summarized and were applied to proposed harvest in the vicinity of this species. The Botany Resource Report (Opolka 2013a) summarizes the avoidance measures unit by unit for this plant.

**Table BOT-2.** Percentage of Known Populations and Estimated Percentage of Individuals of Whiteflower Rein Orchid Directly or Indirectly Affected in the Project Area by the Big Thorne Project

| Type Affected | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | | Alternative 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects |
| Populations Affected | 0 | 0 | 0 | 8 | 0 | 8 | 0 | 4 | 0 | 8 |
| Estimated % of Known Populations Potentially Affected [1/] | 0% | 0% | 0% | 27% | 0% | 27% | 0% | 13% | 0% | 27% |
| Individuals Affected [2/] | 0% | 0% | 0 | 83 | 0 | 83 | 0 | 20 | 0 | 106 |
| Estimated % of Known Individuals Potentially Affected [3/] | 0% | 0% | 0% | 6% | 0% | 6% | 0% | 2% | 0% | 8% |

1/ There are 30 known populations in the project area.
2/ Number of individuals affected was estimated by multiplying the number of individuals identified in a population by the proportion of each population area within the direct or indirect effect zone (see Methods Section). There are approximately 1,319 known individuals in the project area.
3/ There are approximately 1,319 known individuals in the project area.

### Alternative 2

Alternative 2 would have no direct effects on known populations of the whiteflower rein orchid, as all new roads and harvest units avoid known populations. However, this alternative could indirectly affect 8 populations (27 percent of the known populations in the project area) totaling 83 individuals of this plant (approximately 6 percent of the individuals in the project area). The fact that this species apparently occupies a variety of habitat types and light/microclimate conditions also suggests that it is less susceptible to the indirect effects addressed here. This alternative would have similar effects to populations and individuals as Alternative 3, less than Alternative 5, and more than Alternative 4.

### Alternative 3

Alternative 3 would have no direct effects on known populations of whiteflower rein orchid. This alternative could indirectly affect 8 populations (27 percent of the known populations within the project area) totaling 83 individuals of this plant (approximately 6 percent of the individuals within the project area). This alternative would have similar effects to populations and individuals as Alternative 2, less than Alternative 5, and more than Alternative 4.

### Alternative 4

Alternative 4 would have no direct effects on known populations of whiteflower rein orchid. This alternative could indirectly affect 4 populations (13 percent of the known populations within the project area) and 20 individuals of this plant and (approximately 2 percent of the individuals within the project area) would have the lowest effect on individuals and populations among the action alternatives.

#### Alternative 5

Alternative 5 would have no direct effects on known populations of whiteflower rein orchid. This alternative may indirectly affect 8 populations (27 percent of the known populations within the project area) and 106 individuals of this plant (approximately 8 percent of the individuals within the project area). This alternative would have indirect effects to approximately 2 percent more individual plants than any other action alternative.

### *Cumulative Effects*

The following cumulative effects analysis summarizes known effects with respect to biogeographic provinces 14 and 18. Present and reasonably foreseeable projects could affect undetected individuals through timber harvesting and road building activities. There are 41 known populations within biogeographic provinces 14 and 18. Of those 41 known populations, 13 are known along the existing road system, and one additional population is known adjacent to a recreation trail. Because of its prevalence along roadsides, road maintenance activities could affect individuals, however given the high numbers of individuals in the populations known along the road rights-of-way, it is possible that this habitat is favorable for this species. Cumulative effects on potential suitable habitat include effects from past projects and the Big Thorne Project. While reasonably foreseeable projects would contribute to effects on suitable habitat, specific project boundaries are not known for all projects and it is not possible to quantitatively analyze effects to potential suitable habitat for these projects based on the habitat models. This section summarizes cumulative effects by alternative; after that, summaries of cumulative effects for biogeographic provinces 14 and 18 are provided.

#### Alternative 1

Alternative 1 would not result in any direct or indirect effects on known populations as a result of the Big Thorne Project. Past projects have occurred in approximately 11 percent of the estimated potential suitable habitat (based on habitat modeling of current conditions) in biogeographic provinces 14 and 18 (Prince of Wales Island and adjacent islands). Reasonably foreseeable projects would directly affect an additional 4 percent of the estimated potential suitable habitat in biogeographic provinces 14 and 18.

#### Alternatives 2 and 3

Under these alternatives, the Big Thorne Project would not contribute direct effects to any known populations. In biogeographic provinces 14 and 18, this alternative would potentially indirectly affect about 20 percent of the known populations and 6 percent of the known individuals. These alternatives would have slightly less effect than Alternative 5 and more than Alternative 4.

Past projects have occurred in approximately 11 percent of the estimated potential suitable habitat in biogeographic provinces 14 and 18. Reasonably foreseeable projects, combined with contributions by Alternatives 2 or 3, would directly affect an additional 6 percent of the estimated potential suitable habitat.

### Alternative 4

The Big Thorne Project in this alternative would not contribute direct effects to any known populations. In biogeographic provinces 14 and 18, this alternative would potentially indirectly affect about 10 percent of the known populations and 1 percent of the known individuals. This alternative would have the lowest effect on this plant.

In biogeographic provinces 14 and 18, past projects have occurred in approximately 11 percent of the estimated potential suitable habitat. Alternative 4, plus reasonably foreseeable projects, would affect an additional 6 percent of the estimated suitable habitat. This alternative would have slightly lower cumulative effects on potential suitable habitat compared with the other action alternatives.

### Alternative 5

The Big Thorne Project in this alternative would not contribute direct effects to any known populations. In biogeographic provinces 14 and 18, this alternative would potentially indirectly affect about 20 percent of the known populations and 7 percent of the known individuals. This alternative would have indirect effects on this plant comparable to Alternatives 2 and 3 and would affect 6 percent more individuals in the populations compared with Alternative 4.

In biogeographic provinces 14 and 18, past projects have occurred in approximately 11 percent of the estimated potential suitable habitat. Alternative 5, plus reasonably foreseeable projects, would affect an additional 6 percent of the estimated suitable habitat. This alternative would have similar cumulative effects on suitable habitat as the other alternatives.

### Summary of Cumulative Effects

The Big Thorne Project is not expected to contribute any direct effects to the known populations of whiteflower rein orchid, given that there are no direct effects to known populations as a result of the project. The estimated percentage of individuals potentially indirectly affected as a result of the Big Thorne Project in biogeographic provinces 14 and 18 would range from as low as 1 percent (Alternative 4) to as high as 7 percent (Alternative 5). Present and reasonably foreseeable projects include timber harvest, road building and maintenance, recreation, and pre-commercial thinning of young growth.

Other projects that could impact undetected individuals or habitat for this plant in biogeographic provinces 14 and 18 include remaining harvest in the Logjam, Control Lake, Soda/Nick, and Kosciusko, and other timber sale projects, as well as additional harvest on non-NFS lands.

Of the 41 known populations in the biogeographic provinces, the only reasonably foreseeable timber project with possible effects to known populations is within the Kosciusko Vegetation Management Plan. During surveys for that project, one population was found within a preliminary version of the unit pool. That project is still in the preliminary stages and will go through the similar analysis and design criteria as used for Big Thorne.

As mentioned previously, 13 populations are known along rights-of-way and edges of the existing road system. While these populations may have impacts to individuals, given the current high numbers at each population, it is possible that these locations are providing favorable habitats for this species. The same may be true for the population known along the edge of the trail to the Twelvemile Cabin.

Although no additional known affects to this species have been identified, it should be noted that it has only recently been verified in Alaska, and thus may not have been a targeted species in earlier surveys. Identification of this plant can be difficult unless the plant is flowering, which requires that the surveys be conducted at the right time of year for identification. Although undetected populations could be present, it is likely that the degree of effect on this species as a result of past timber sale projects was relatively low, since this plant commonly grows near muskeg edges in unproductive timber areas that are not commercially viable for harvest. Additional harvest on state and private lands is expected to have similar effects to those on NFS lands, based on suitable habitat known for the species.

Past harvest has occurred in about 11 percent of the modeled potential suitable habitat in biogeographic provinces 14 and 18. Cumulatively, if the Big Thorne harvest is added to reasonably foreseeable projects, an additional 6 percent of the modeled potential suitable habitat would be directly affected under all action alternatives.

The most common natural habitats for whiteflower rein orchid found during surveys for the Big Thorne project were along the very outer edge of the forest, along a muskeg, or sheltered under patches of scrub timber, typically less than 5 feet tall, scattered throughout the muskeg systems.

Within the analysis area of biogeographic provinces 14 and 18, the Big Thorne Project could result in indirect effects to portions of up to 20 percent of the known populations of whiteflower rein orchid (or 27 percent within the project area).

In summary, because none of the alternatives for the Big Thorne Project would result in direct effects on known populations, and because 44 to 59 percent of the known individuals in the project area occur within non-development LUDs (see Issue 2: Old-Growth Habitat LUD Modifications), it is concluded that the project may adversely affect individuals, but is not likely to result in a loss of viability in biogeographic provinces 14 and 18 or on the Tongass, nor would it cause a trend toward Federal listing for any of the action alternatives.

Refer to the Botany Resource Report in the Big Thorne Project record for a more detailed evaluation, including descriptions by unit of indirect effects. The Resource Report also includes discussion on the distances from harvest, edge habitat of the known plant populations, and proximity to other known populations.

### Lesser Round-Leaved Orchid (Sensitive Species)

The lesser round-leaved orchid has been documented on the Tongass National Forest within 298 distinct populations comprising a total of 6,924 individual plants. In the Big Thorne project area, this species was observed in 120 populations comprising 4,019 individual plants. As such, the Big Thorne project area comprises 40 percent of the known populations with 58 percent of the known individuals within the Tongass National Forest. Survey efforts covered approximately 6,600 acres within the project area, including over 2,300 acres within the unit pool. Well over 4,000 acres of the total survey area in the project area (including over 1,000 acres of the surveys within the unit pool) were considered potential suitable habitat in the project area (based on generalized habitat modeling). This translates to approximately 38 percent of the potential suitable habitat surveyed.

*Direct and Indirect Effects*

Direct and indirect effects to lesser round-leaved orchid are summarized by alternative below and in Table BOT-3. All of the action alternatives have effects on lesser round-leaved orchid. Avoidance and minimization measures were previously summarized and were applied to proposed harvest in the vicinity of this species. Appendix D in the Botany Resource Report (Opolka 2013a) and the unit cards in the project record summarize the avoidance measures unit by unit for this plant.

**Table BOT-3.** Percentage of Known Populations and Estimated percentage of Individuals of Lesser Round-Leaved Orchid Directly or Indirectly[1/] Affected in the Project Area by the Big Thorne Project

| Type Affected | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | | Alternative 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects | Direct Effects | Indirect Effects |
| Populations Affected | 0 | 0 | 25 | 17 | 31 | 23 | 6 | 25 | 22 | 27 |
| Estimated Percentage of Known Populations Potentially Affected in Project Area[2/] | 0% | 0% | 21% | 14% | 26% | 23% | 5% | 23% | 18% | 27% |
| Individuals Affected[3/] | 0 | 0 | 145 | 306 | 276 | 622 | 10 | 318 | 171 | 379 |
| Estimated Percentage of Known Individuals Potentially Affected in Project Area[4/] | 0% | 0% | 4% | 8% | 7% | 16% | 0.3% | 8% | 4% | 10% |

1/ Indirect populations potentially affected in the table include only those in addition to the ones directly affected to avoid double counting.
2/ There are 120 known populations in the project area.
3/ Number of individuals estimated by multiplying the number of individuals identified in a population by the proportion of that population area within the direct or indirect effect zone (see Methods Section).
4/ There are approximately 4,019 known individuals in the project area.

Alternative 2

This alternative would directly affect 25 of the 120 known populations and an estimated 145 individuals of this plant in the project area. This reflects a direct effect on 21 percent of the known populations in the project area, although only 4 percent of the total individuals known to inhabit the project area would be directly affected.

This alternative could indirectly affect 17 additional known populations and an estimated 306 individuals of this plant. This reflects a potential combined direct or indirect effect on 35 percent of the known populations in the project area, although just 11 percent of the total known individuals in the project area could be directly or indirectly affected. Alternative 2 would be intermediate in terms of direct and potential indirect effects on the lesser round-leaved orchid.

### Alternative 3

Alternative 3 would directly affect 31 known populations and an estimated 276 individuals of this plant. This reflects a direct effect on 26 percent of the known populations in the project area and 7 percent of the total individuals in the project area.

This alternative could indirectly affect 23 additional known populations and an estimated 622 individuals of this plant. This reflects a potential combined direct or indirect effect on 49 percent of the known populations in the project area and 22 percent of the total known individuals in the project area. Alternative 3 would have the highest direct and potential indirect effects among the action alternatives on the lesser round-leaved orchid.

### Alternative 4

Under this alternative, sensitive plant populations were often deferred from harvest, by either excluding the plant population from the unit or through including the population in unharvested areas of units with partial-harvest prescriptions. This alternative would directly affect 6 known populations and an estimated 10 individuals of this plant. This reflects a direct effect on 5 percent of the known populations in the project area and 0.3 percent of the total known individuals known to inhabit the project area.

This alternative could indirectly affect 25 additional known populations and an estimated 318 individuals of this plant. This reflects a potential combined direct or indirect effect on 28 percent of the known populations in the project area and 8 percent of the total known individuals in the project area. Alternative 4 would have the lowest level of direct and potential indirect effects, much lower than with the other action alternatives.

### Alternative 5

This alternative would directly affect 22 known populations and an estimated 171 individuals of this plant. This reflects a direct effect on 18 percent of the known populations in the project area and 4 percent of the total known individuals in the project area.

This alternative could indirectly affect 27 additional known populations and an estimated 379 individuals of this plant. This reflects a combined direct or indirect effect on 45 percent of the known populations in the project area and 14 percent of the total known individuals in the project area. Alternative 5 would be intermediate in terms of direct and potential indirect effects on the lesser round-leaved orchid among the action alternatives.

#### *Cumulative Effects*

The following cumulative effects analysis summarizes known effects with respect to biogeographic provinces 14 and 18. Present and reasonably foreseeable projects could affect known and undetected individuals and populations through timber harvesting and road building activities. Cumulative potential suitable habitat includes past projects and the Big Thorne Project. While current or reasonably foreseeable projects would likely contribute to effects on suitable habitat, specific project boundaries are not known for all projects and it is not possible to quantitatively analyze effects to potential suitable habitat for these projects based on the habitat models. This section summarizes cumulative effects by alternative; after that, summaries of cumulative effects for biogeographic provinces 14 and 18 are provided.

### Alternative 1

Alternative 1 would not result in any direct or indirect effects on any known populations or individual plants, as a result of the Big Thorne Project. Therefore, the Big Thorne Project would not contribute to the cumulative effects for the analysis area, under this alternative.

One known population has been directly impacted by harvest of the Slake timber sale from the Logjam EIS, and one population of two plants is known within a preliminary version of the Kosciusko Vegetation Management Plan unit pool.

Past projects have occurred in approximately 16 percent of the estimated potentially suitable habitat in biogeographic provinces 14 and 18 (Prince of Wales Island and adjacent islands). The reasonably foreseeable projects, would directly affect an additional 1 percent of the estimated suitable habitat.

### Alternative 2

For biogeographic provinces 14 and 18, this alternative would directly affect 3 percent and indirectly affect 7 percent of the known individuals (10 percent cumulatively). Similarly, Alternative 2 would directly affect, at least portions of 18 percent of the known populations, and could indirectly affect 21 percent. Cumulatively, this could represent at least partial effects on 30 percent of the known populations. Alternative 2 would be intermediate in terms of cumulative effects for these provinces.

Within biogeographic provinces 14 and 18, past projects have occurred in approximately 16 percent of the estimated potential suitable habitat. Alternative 2, combined with reasonably foreseeable harvest, would directly affect slightly more than 1 percent of additional suitable habitat. This alternative would affect less suitable habitat than Alternatives 3 and 5 and a similar amount as Alternative 4.

### Alternative 3

For biogeographic provinces 14 and 18, this alternative would directly affect about 6 percent and indirectly affect about 14 percent of the known individuals (20 percent cumulatively). Similarly, Alternative 3 would directly affect, at least portions of 22 percent of the known populations, and could indirectly affect 29 percent. Cumulatively, this could represent at least partial effects on 38 percent of the known populations. This alternative would have the highest cumulative effects on this plant.

For biogeographic provinces 14 and 18, past projects have occurred in approximately 16 percent of the estimated potential suitable habitat. Alternative 3, combined with reasonably foreseeable harvest, would directly affect about 1.5 percent of additional suitable habitat. This alternative would affect the greatest amount of suitable habitat among the alternatives.

### Alternative 4

For biogeographic provinces 14 and 18, this alternative would directly affect about 0.2 percent and indirectly affect 7 percent of the known individuals (7 percent cumulatively). Similarly, Alternative 4 would directly affect, at least portions of 4 percent of the known populations, and could indirectly affect 21 percent. Cumulatively, this could represent at least partial effects on 22 percent of the known populations. This alternative would have the lowest cumulative effect on this species.

For biogeographic provinces 14 and 18, past projects have occurred in approximately 16 percent of the estimated potential suitable habitat. Alternative 4, combined with reasonably foreseeable harvest, would directly affect slightly over 1 percent of additional suitable habitat. This alternative would affect less suitable habitat than Alternatives 3 and 5 and a similar amount as Alternative 2.

Alternative 5

For biogeographic provinces 14 and 18, this alternative would directly affect about 4 percent and indirectly affect 8 percent of the known individuals (12 percent cumulatively). Similarly, Alternative 5 would directly affect, at least portions of 16 percent of the known populations, and could indirectly affect 28 percent. Cumulatively, this could represent at least partial effects on 35 percent of the known populations. This alternative would have intermediate cumulative effects relative to the other alternatives.

For biogeographic provinces 14 and 18, past projects have occurred in approximately 16 percent of potential suitable habitat. Alternative 5, combined with reasonably foreseeable harvest, would directly affect almost 1.5 percent of additional suitable habitat. This alternative would have intermediate effects on potential suitable habitat relative to the other alternatives.

### Summary of Cumulative Effects and Determination

Present and reasonably foreseeable projects for biogeographic provinces 14 and 18 include timber harvest, and road building, recreation, and the potential for commercial thinning of young growth. Some timber projects that could impact undetected individuals or habitat for this plant in biogeographic provinces 14 and 18 include remaining harvest in the Logjam, Control Lake, Soda/Nick, and other projects, the planned Kosciusko Vegetation Management project, and State and private harvest.

There are 141 known populations of lesser round-leaved orchid within biogeographic provinces 14 and 18, totaling an estimated 4,467 plants. The cumulative effects to known individuals in biogeographic provinces 14 and 18, as a result of the Big Thorne project vary by alternative. Alternative 4 has the least effects to known populations, and Alternative 3 has the highest. In addition to the potential impacts from the Big Thorne Project, the only known impact to known individuals of lesser round-leaved orchid within the analysis area was within a Slake Timber Sale unit from the Logjam project. In addition, there is one population of two plants within a planned preliminary unit for the Kosciusko Vegetation Management Plan.

There are several populations known near developed recreation areas, both on NFS lands and non-NFS lands. These populations were documented through informal monitoring rather than baseline surveys before the sites were developed. They have not shown a decrease in population or individuals as a result of human use. Although additional plants were not found during other project surveys, this species was not on the Sensitive Species List until 2009 and was not targeted for surveys in many previous projects.

The estimated percentage of known individuals directly affected in biogeographic provinces 14 and 18 as a result of the Big Thorne Project would range from 0.2 percent (Alternative 4) to 6 percent (Alternative 3). In addition, the estimated percentage of individuals potentially indirectly affected in these provinces as a result of the Big Thorne Project could range from 7 percent (Alternatives 2 and 4) to 14 percent (Alternative 3). Cumulatively, the combined direct and indirect effects on known individuals could range from 7 to 20 percent. It should be noted that indirect effects, which represent a much larger component of these percentages than direct effects, are less likely to occur than direct effects in this case, and, if they do occur, are less likely to be severe. Direct effects are almost sure to occur and may include direct crushing or uprooting, and significant disruptions in shade and microclimate. Indirect effects on the other hand would not include direct crushing or uprooting of individuals, and changes in shade and microclimate would be lower in severity. Furthermore, plants at the outer edges of the defined indirect effects zone are very unlikely to be affected at all.

The estimated percentage of known populations that would be directly affected, at least in part, within biogeographic provinces 14 and 18 as a result of the Big Thorne Project would range from 4 percent (Alternative 4) to 22 percent (Alternative 3). In addition, the estimated percentage of populations potentially indirectly affected in these provinces as a result of the Big Thorne Project could range from 21 percent (Alternatives 2 and 4) to 29 percent (Alternative 3). Cumulatively, the combined direct and indirect effects on known populations could range from 22 percent (Alternative 4) to 38 percent (Alternative 3).

Past projects have occurred in approximately 16 percent of estimated potential suitable habitat in biogeographic provinces 14 and 18. The Big Thorne Project, plus other reasonably foreseeable harvest (including non-NFS harvest), would directly affect an additional 1 to 1.5 percent of the estimated potential suitable habitat.

In order to evaluate the impact on the extent of the distribution of lesser round-leaved orchid with respect to the Tongass National Forest, the distribution of populations across the Forest were mapped. A total of 298 known populations of lesser round-leaved orchid and 6,924 individuals are known on the Tongass National Forest. The majority of individuals (4,467), and about half of the populations (141) occur in biogeographic provinces 14 and 18. Additional populations of this plant are found in two other biogeographic provinces. Thirty-four populations of about 519 plants are in biogeographic province 13, to the northeast of the project area and 123 populations; totaling about 553 plants are in biogeographic province 15 located east and southeast of the project area.

While attempts were made for every action alternative for the Big Thorne Project to avoid, minimize and mitigate the effects to lesser round-leaved orchid, due to the prevalence of the plant in the project area, and within habitats suitable for timber harvest, direct and indirect effects are expected to individual plants and habitat under every action alternative.

Alternative 4 is designed to avoid these sensitive plants as much as possible resulting in less affects to these plants than in the other action alternatives. Specific avoidance design measures can be found in the project botany resource report and the individual harvest unit and road cards in the project record. While some negative effects are likely, the avoidance measures applied in the alternative design have minimized these effects, whereby the determination can be made that Alternative 4 may adversely impact individuals, but is not likely to result in a loss of viability in the Planning Area, nor cause a trend toward federal listing.

Avoidance of lesser round-leaved orchid plants within the unit design for Alternatives 2, 3, and 5 will be to a lesser degree compared to Alternative 4, in order to meet the objectives for those alternatives. For these action alternatives, 49 percent or less of the known populations and 23 percent or less of the known individuals will be affected (direct and indirect) within in the project area. However, 60 percent of the total known populations and 42 percent of the total known individuals of this species are currently known to exist outside the Big Thorne project area (elsewhere on the Tongass N.F.). The result is that the unaffected individuals and populations within the project area combined with the individuals and populations outside the project area represent greater than half of the known plants in the Planning Area. This proportion of plant populations and individuals represents a reasonable estimate for at least a minimum number of reproductive individuals well distributed within their geographic range on the Tongass N.F. While some negative effects are likely, the determination can be made that Alternatives 2, 3 and 5 may adversely impact individuals, but is not likely to result in a loss of viability in the Planning Area, nor cause a trend toward federal listing.

In summary, the Big Thorne Project would directly affect between 0.2 percent (Alternative 4) and 5 percent (Alternative 3) of the known individual plants on the Tongass. About 35 percent of all the known individuals in the project area are in non-forest or unproductive old-growth habitats (i.e., unlikely to be harvested). The Big Thorne Project would not directly affect at least 93 percent of the known individuals in the project area, even under Alternative 3. Also, a minimum of 25 of the 34 known populations in the project area containing 20 or more individuals would not be directly affected.

The potential indirect effects range from 8 to 16 percent of the individuals in the project area. A maximum of 18 of the 70 populations (26 percent) on the Tongass National Forest containing 20 or more individuals could be directly or indirectly affected by the project, so 74 percent of these larger populations would not be affected. In addition, over 120 individual plants and about 5 percent of all known populations of this plant were located entirely in young-growth, mostly from 40 to 50 years old. Although there are many unknowns surrounding these plants, they are apparently not restricted to productive old-growth stands. Further, 43 to 65 percent of the known individuals in the project area would occur within non-development LUDs (see Issue 2: Old-Growth Habitat LUD Modifications) after project implementation. With additional survey efforts in suitable habitat, it may be possible to locate additional individuals and populations in both non-development and development LUDs within the project area, given the prevalent occurrence of this plant. Survey efforts to date have covered 3.4 percent of project area development LUDs and only 2.5 percent of project area non-development LUDs.

For these reasons, it is expected that the project may adversely affect individuals, but is not likely to result in a loss of viability in on the Tongass National Forest nor cause a trend toward Federal listing for any of the alternatives. Refer to the Botany Resource Report (Opolka 2013a) in the Big Thorne Project record for a unit by unit explanation detailing direct and indirect effects and mitigation.

## Mitigation and Monitoring

### *Mitigation*

Extensive avoidance and minimization measures were incorporated into project design and are described under Avoidance and Minimization Measures near the beginning of the Environmental Consequences section. These measures were taken to prevent or reduce effects to known populations of sensitive and rare plants and to ensure the viability of sensitive and rare plants in the project area.

In addition to the avoidance and minimization measures, the following additional measure is recommended during project implementation:

- Project-related dust may indirectly affect one known population of the lichen, *Lobaria amplissima,* located close to NFS road 300000 (the Sandy Beach Road) at milepost 24.8. To minimize effects on this population, it is recommended that consideration be given to using the provision of the contract clause for application of water to the road surface within 300 feet of this population to reduce dust, if the amount of dust is expected to increase with the use of the road for a particular contract. Frequency of water application would be dependent on the road use intensity and weather conditions.

### *Monitoring*

Monitoring is recommended for rare and sensitive plants in association with this project. The ongoing Forest-wide monitoring in conjunction with Project-specific monitoring will contribute to the base information for populations within the Big Thorne project area and on Prince of Wales Island. The Big Thorne Monitoring and Evaluation Plan for Rare and Sensitive Species can be found within the Big Thorne Project record and includes detailed information on monitoring objectives and timelines based on actions proposed.

# Invasive Plants

## Introduction

This analysis is based on known invasive plants and their expected response to habitat alteration and vectors as a result of project activities. Species are considered invasive if they are not native to an ecosystem and are likely to cause harm to human health, the economy, or the environment (Executive Order [EO] 13112).

In October 2007, the Tongass National Forest adopted guidelines for invasive plant management with a supplement to FSM 2080 (Supplement No. R10 TNF-2000-2007-1). The objective of this supplement is to provide an integrated pest management approach for managing invasive plants on the Tongass National Forest. This supplement requires the development of a risk assessment as part of an environmental analysis for ground-disturbing activities. The risk assessment for this project is in the Big Thorne Project record (Opolka and Fairbanks 2013b). The 2008 Forest Plan includes direction on invasive species, which include the overall context of desired conditions (see Biodiversity goals and objectives) as well as standards and guidelines for invasive species. These were based on a number of laws, but most directly on EO 13112. Specifically, EO 13112 directs all Federal agencies to address the impacts that their actions may have on invasive species. In December 2011, the Forest Service issued a new manual, FSM 2900, Invasive Species Management, which sets forth National Forest System policy, responsibilities, and direction for the prevention, detection, control, and restoration of effects from aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens).

The ANHP's Weed Ranking Project (see http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm) was used to develop a list of target invasive plants about which the Forest has concerns. This ranking process takes into account the following characteristics for each plant species: potential ecological impact, biological characteristics, dispersal ability, current distribution, and the feasibility of control. Plants are then ranked on a scale of 0-100, with 100 having the highest invasiveness rank. The Tongass National Forest High-Priority Invasive Plant Species List is a list of target plants of which the Forest is most concerned (USDA Forest Service 2007a). This list uses the ANHP Weed Ranking Project results to rank the invasiveness of each species. Those species known to occur on the Forest, as well as several not yet here, with a ranking higher than 60 are highlighted for management concerns. In addition to the target list of high priority species, the Tongass is also concerned about other species not on this list, depending on their abundance, location, and threats to ecosystem functions and/or biodiversity.

### Methodology

Invasive plant surveys were conducted on Prince of Wales Island in 2005 for all Maintenance Level 3 and 4 road systems. This project included surveys every ¼ mile along the road system as well as at each intersection and rock quarry encountered. Overall, 2,635 non-native plant sites were documented in areas such as rock quarries, road intersections, and road pullouts. The survey covered approximately 584 miles of road. Surveys were done at the appropriate time of year to identify the broadest range possible of non-native plant species.

In addition to the contract invasive plant surveys in 2005, surveys in the Big Thorne project area were conducted in 2009, 2010, 2011, and 2012 along existing system roads, temporary roads, landings, LTFs and in natural settings. If any non-native plants were observed, the boundary of the infestation was recorded with GPS and delineated in GIS.

## Affected Environment

A total of 62 non-native plant species are documented to occur within the project area. Of these, 11 are classified as high-priority invasive plant species by the Tongass National Forest. Table INV-1 summarizes these plants, their invasive ranking, and the populations and locations in the project area.

**Table INV-1.** High Priority Invasive Plant Species found in the Project Area

| Scientific Name | Common Name | Invasive Rank[1/] | Populations and Location[2/] |
|---|---|---|---|
| *Cirsium arvensis* | Canada thistle | 76 | 6 populations; SE and SW portion of project area |
| *Cirsium vulgare* | bull thistle | 61 | 27 populations; SE and SW portion of project area |
| *Hieracium aurantiacum,* | orange hawkweed, | 79 | 120 populations; scattered primarily in southern portion of project area |
| *Hieracium caespitosum* | meadow hawkweed | 79 | 3 populations; 1 population in NE portion of project area, 2 populations near southern edge of project area |
| *Senecio jacobaea* | tansy ragwort | 63 | 2 populations; located near project boundary in southern and SE portion of project area |
| *Sonchus arvensis* | perennial sowthistle | 73 | 5 populations in southern portion of project area |
| *Crepis tectorum* | narrow-leaf hawk's beard | 54 | 18 populations in southern portion of project area |
| *Leucanthemum vulgare* | oxeye daisy | 61 | 183 populations, ubiquitous |
| *Melilotus alba* | white sweetclover | 81 | 1 population in southeastern corner of project area |
| *Phalaris arundicacea* | reed canarygrass | 83 | 620 populations, common along existing roads and has been found in riparian areas |
| *Tanacetum vulgare* | common tansy | 60 | 6 scattered populations |

1/ Numerical Rankings assigned according to the Alaska Natural Heritage Program's (ANHP) Weed Ranking Project. Ranked on a scale of 0-100, with 100 having the highest invasiveness risk.
2/ Populations primarily located adjacent to roads; maps of invasive plant populations available in the Big Thorne Project record.

### Invasive Plant Risk Assessment

The invasive plant risk assessment was conducted according to FSM 2080 (Supplement No. R10 TNF-2000-2007-1), which requires an invasive plant risk assessment for ground-disturbing activities. The risk assessment evaluates the locations of known invasive plants, existing habitat vulnerability, and the potential response of invasive plants as a result of project actions that result in habitat alteration and increased vectors. Additional details regarding the basis of risk assessment are included in the Environmental Consequences section. The invasive plant risk assessment (Opolka and Fairbanks 2013b) and Invasive Species Resource Report (Opolka 2013b) are also in the Big Thorne Project record.

In an attempt to limit the spread of invasive plants during project implementation, the following mitigation and monitoring measures are recommended for the project:

- Mitigation Measures
  - In order to avoid the introduction of new invasive plants into the project area, ground-based equipment (road building equipment, yarders, shovels, skidders, forwarders, harvesters, processors or feller bunchers, etc.) will be cleaned prior to implementation and mobilization, if the equipment is imported to Prince of Wales Island from another location.
  - Only Forest Service approved rock sources will be used.
  - Any new introductions of high-priority invasive plants found in the project area will be treated according to Forest Service Manual supplement (TNF 2000-2007-1), and the Region 10 and Tongass Invasive Plant Management Plan as part of the District's program of work for invasive species management.
  - The specific invasive plant populations in Table INV-2 have been identified for manual treatment (hand-pulling) or monitoring based on their limited distribution in the project area, potential for spread, and feasibility for treatment.
- Monitoring Measures
  - Newly constructed roads, existing roads that were improved, and any active rock quarries in the project area will be monitored for at least 3 years after project completion for new non-native plant introductions.
  - Monitor treated plant populations as noted in Table INV-2 and according to the Tongass Invasive Plant Management Plan and the District's program of work.

### Ongoing Treatments

Independent of the mitigation and monitoring measures recommended for the project, the Forest Service also has an ongoing invasive plant program of work. This work varies from year to year, and will continue as funding allows. In the past several years, this program has monitored and treated a number of infestations in the vicinity of the project area. A summary of past treatment information is available in the Big Thorne Project record.

**Table INV-2.** Specific Invasive Plant Populations for which Treatment is Recommended

| Species | Location | Comments |
|---|---|---|
| *Cirsium arvensis* Canada thistle | Two populations, one each by Units 26 and 116 | Both have been treated in the past, recommend monitoring and follow-up treatments |
| *Cirsium vulgaris* bull thistle | Several populations located by Units 1, 2, 4, 22, 56, 501, 502, | All have been treated in the past, recommend monitoring and follow-up treatments |
| *Crepis tectorum* narrow-leaf hawk's beard | Two populations, one each by Units 6 and 81 | Treatment is recommended for the infestation near unit 6, and monitoring is recommended for the infestation near unit 81. If the rockpit is planned for use, treatments may be necessary prior to approval. |
| *Senecio jacobaea* tansy ragwort | One population by Units 58 and 59, one population along haul route by Sandy Beach | All locations have been treated. The population by Units 58 and 59 is not known to persist; this location should be monitored and treated if plants are observed. The population by Sandy Beach is known to persist and should be treated. |
| *Sonchus arvensis* perennial sowthistle | One population adjacent to the existing road that goes through Unit 504 | Treatment recommended |
| *Tanacetum vulgare* common tansy | Two populations by Unit 363, three additional populations by Units 68, 135, and 572 | Populations by Units 68 and 135 have been treated; monitoring has not observed continued infestations. These locations should continue to be monitored and treated if plants are observed. Populations by Units 363 and 572 should be treated. |
| *Melilotus alba* white sweet clover | 1 population in southeastern corner of project area west of Unit 123. | Population has been treated; monitor and treat if plants are observed. |

## *Environmental Consequences*

All of the alternatives would result in some risk to the spread of invasive plants in the project area; even the No-action Alternative would have a moderate risk of spread due to existing invasive plants and traffic along the road system. Overall risk of invasive plant spread under the action alternatives is moderate to high along roadsides. However, risk of introduction of new invasive plants and spread of existing invasives into natural habitats and along temporary roads is considered low to moderate and short term (Opolka and Fairbanks 2013b).

Mitigation measures have been designed to minimize the risk of invasive plant spread. The risk of invasive plant spread can be measured through the vectors in the analysis area, habitat vulnerability, and the proximity of existing invasive plant infestations. These are described in more detail in the Invasive Plant Risk Assessment (Opolka and Fairbanks 2013b), available in the Big Thorne Project record.

The relative potential for invasive plant spread can be measured through the acres harvested, miles of road built, number of stream crossings, and acres of rock quarries developed as a result of the project and can be compared by alternative. The effects of project actions are described below with respect to risk of invasive plant spread. Potential project effects that may result in invasive plant spread or establishment are indirect effects. As a result of habitat alteration and/or vectors, invasive plant spread could result from project activities. These are discussed in a comparative format in the following subsections.

## Effects from Timber Harvest

Habitat alteration as a result of the project will occur as timber is harvested in the project area, resulting in an increase in the acreage of habitat altered through clear cutting and partial harvest of old growth and the thinning of young growth. These actions could create habitat conditions vulnerable to invasive plant establishment with increased light levels until trees become well established, and proximity to existing populations of invasive plants. Timber harvesting would also remove wind-breaks, thereby creating new wind-paths that could spread seeds.

The project would use a combination of conventional (cable and shovel) and helicopter harvesting methods. The logging system used also affects risk because of variability in habitat alteration due to ground disturbance and an increase in vectors. Slightly higher risk is associated with conventional (shovel or cable) logging systems compared with helicopter. Tongass soil monitoring shows a small difference in detrimental soil disturbance between partial suspension (cable and shovel) (3 percent) and full suspension (helicopter) (2 percent) (Landwehr and Nowacki 1999). Persistence of invasives is not likely to occur in these areas.

Another factor in the risk of invasive plant spread relative to harvesting method (conventional versus helicopter) is the proximity to existing roads, which often harbor invasive plants. Helicopter units are frequently located in more remote areas without road access, and thus in areas that are less likely to be infested with invasive plants. Alternatively, conventional harvesting requires road access and equipment usage in the unit (for shovel harvesting) and thus an increased exposure to invasive plants. The risk associated with invasive plant spread into harvest units is temporary. As these areas revegetate, invasive plants are expected to be out-competed by native vegetation, and are eventually shaded out.

Harvest prescriptions would include clearcuts and partial harvests of old growth and thinning of young growth. Risk associated with harvest prescription is related to the amount of light reaching the ground surface. Clearcuts result in removal of the tree canopy, high light levels, and have a higher risk of invasive plant spread. Partial harvests and thinning result in partial canopy removal and moderate lower risk of invasive plant spread due to increased light levels. While the overall acres harvested is a factor and will be considered in this analysis, the highest overall risk of invasive spread due to harvesting, when also considering habitat alteration and vectors comes from roads; limited risk is associated with conventionally harvested (shovel and cable) clearcuts, while the very low overall risk is associated with partial harvesting by helicopter. Again, however, the risk directly associated with harvest is temporary and any invasives that become established in harvest units would normally be out-competed or shaded out by tree growth.

**Table INV-3.** Summary of Harvest Unit Acres and Acres of Soil Disturbance by Logging System, Prescription, and Alternative

| Logging System | Alternative | Old Growth Clearcut | Old Growth Partial Harvest | Young Growth Thinning | Total Harvest Unit Acres | Estimated Acres of Soil Disturbance1/ |
|---|---|---|---|---|---|---|
| Conventional (Shovel, Cable) | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 3,216 | 0 | 0 | 3,216 | 96 |
| | 3 | 4,101 | 0 | 2,299 | 6,400 | 192 |
| | 4 | 710 | 327 | 1,888 | 2,925 | 88 |
| | 5 | 1,695 | 0 | 1,850 | 3,545 | 106 |
| Helicopter | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 699 | 1,205 | 0 | 1,904 | 38 |
| | 3 | 836 | 2,182 | 0 | 3,018 | 60 |
| | 4 | 272 | 3,448 | 0 | 3,720 | 74 |
| | 5 | 758 | 2,999 | 0 | 3,757 | 75 |
| Total | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 3,915 | 1,205 | 0 | 5,121 | 135 |
| | 3 | 4,938 | 2,182 | 2,299 | 9,419 | 253 |
| | 4 | 982 | 3,776 | 1,888 | 6,645 | 162 |
| | 5 | 2,453 | 2,999 | 1,850 | 7,302 | 182 |

1/ Yarding disturbances based on an estimate of 3% of the harvest area where partial suspension or shovel yarding is proposed and 2% where full suspension is proposed; excludes roads (see Table SOIL-4).
2/ Numbers in the table may not sum exactly due to rounding.

## Effects of Roads

Roads may result in altered habitat susceptible to invasive plant spread and their use and creation may result in additional vectors that could spread invasive plants. Use of roads by people and animals provides a source of invasive plant dispersal. People may spread invasive plants along roads by transporting seeds on their shoes, clothing, and vehicles. New road construction would also alter habitat and create areas of continuous soil disturbance (especially while the roads are open and drivable) and open habitats where invasive plants may continue to spread. Vehicles and equipment (both off and on-road) use could also transport these invasive plants along the road network and into the forest. Road maintenance including vegetation mowing also may disperse invasive plants along the road system. Many of the existing invasive plants present along the road network may also spread through wind and water dispersal. All of these vectors contribute to invasive plant dispersal and it is difficult to determine which vector has the greatest impact. The combination of these vectors results in a high risk of spread of invasive plants along the roadway, substantiated by the presence of invasive plants along the existing road system.

Although the risk of invasive plant spread along existing roadways is moderate to high, risk of spread into forested habitats is generally low due to existing dense vegetation cover. While the majority of invasive plants are located along the road system, invasive plants can spread into other natural habitats. For example, the seeds of reed canarygrass may enter roadside drainages and be transported into streams and wetlands. Similarly, the windblown seeds of invasive plants may be transported into vulnerable habitats. The project will involve the construction or reconstruction of new roads; the type of road constructed (i.e., long term or short term) impacts the risk of invasive spread. Roads open permanently would create long-term opportunities for invasive plant spread and establishment. Temporary roads or roads that would be decommissioned after use are expected to become vegetated with native species eventually, but would present a risk in the shorter term for invasive plant introduction and spread. New system roads created for the project will remain open for 1 to 5 years after harvest, with temporary roads typically open for a shorter period. Between 1 and 5 miles of road (depending on alternative) will be converted to motorized trail use, resulting in long-term habitat alteration and vectors along these trails. Existing roads that will require maintenance for the project are a concern due to the potential for invasive plants to be transported to new areas during maintenance activities and new ground disturbance that could be vulnerable to new invasive plant infestations. While each type of road may have effects on invasive plant spread, the overall total road miles for each alternative has the greatest effect for invasive spread, since populations of invasive plants are concentrated along the road network and are likely to spread along this network due to the vectors and habitat vulnerability described above. The number of stream crossings required generally increases along with road mileage. Each road-stream crossing alters riparian habitat, resulting in vulnerability due to vegetation removal, increased light, and soil disturbance. Similar to roadways, rock quarry development also creates a habitat vulnerable to invasive plant infestations, due to the frequency of substrate disturbance and open habitat.

Implementation of any of the action alternatives may result in establishment of invasive plants, as all action alternatives will result in habitat alteration from tree harvesting, road construction, stream crossings, and rock quarry development. However, the logging methods and prescriptions, miles of road constructed, and rock quarries developed vary substantially among alternatives as does the potential risk of invasive plant introduction and spread. These are discussed by alternative in the following section and summarized Table INV-4.

**Table INV-4.** Summary of Harvest Unit Acres, Road Construction, Number of Stream Crossings, and Acres of Rock Quarry as a result of the Big Thorne Project

| Alternative | Total Harvest Unit Acres (including young-growth thinning) | Total Miles of Road Construction and Reconstruction[1/] | Number of New Stream Crossings[2/] | Acres of Rock Quarries[3/] |
|---|---|---|---|---|
| Alternative 1 | 0 | 0 | 0 | 0 |
| Alternative 2 | 5,121 | 50 | 14 | 26 |
| Alternative 3 | 9,419 | 88 | 26 | 37 |
| Alternative 4 | 6,645 | 31 | 1 | 3 |
| Alternative 5 | 7,302 | 34 | 1 | 9 |

1/ Includes all types of road construction and reconstruction.
2/ Includes all crossings of stream classes 1-3 by proposed new project roads (does not include reconstruction or construction on existing decommissioned road beds).
3/ Assumes 1-acre of rock quarry development needed for every mile of new road construction, not including construction on decommissioned road beds.

### Alternative 1 (No Action) – Direct and Indirect Effects

Habitat alteration and the vectors associated with the Big Thorne Project under this alternative would be the same as existing conditions; there would be no tree harvesting, new stream crossings, rock quarries, or road building due to the Big Thorne Project. As a result, there would be no increase in the risk of invasive plant spread as a result of the Big Thorne Project.

### Alternative 2 (Proposed Action) – Direct and Indirect Effects

Alternative 2 proposes approximately 50 total miles of road construction and reconstruction, including 18 miles of reconstruction of stored system roads, 8 miles of new system road, and 24 miles of new temporary road. This alternative also proposes 14 new stream crossings and the construction of approximately 26 acres of rock quarries. Effects of these actions are discussed in detail under the preceding road construction effects section.

This alternative includes mostly clearcutting and a lesser amount of partial-cutting prescriptions, using conventional (cable and shovel) logging systems and helicopter yarding to harvest old-growth timber on about 5,121 total acres. Alternative 2 would result in 3,216 acres of conventionally harvested clearcut, which has the highest risk for invasive plant spread, considering harvest prescription and harvest method (described in the Effects from Timber Harvest subsection above). This alternative would have the second-highest amount of total road construction, stream crossings, rock quarry development, and conventionally harvested clearcuts. Correspondingly, it would have the second-highest level of risk for invasive plant spread among the alternatives, based on these actions.

### Alternative 3 – Direct and Indirect Effects

This alternative proposes approximately 88 total miles of road construction and reconstruction, consisting of 37 miles of reconstruction of stored system roads, 14 miles of new system road, and 37.5 miles of new temporary road. This alternative also proposes 26 new stream crossings and the construction of approximately 37 acres of rock quarries. Effects of these actions are discussed in detail under the preceding road construction effects section.

Alternative 3 includes mostly clearcutting and a lesser amount of partial-cutting prescriptions, using conventional (cable and shovel) logging systems and helicopter yarding to harvest old-growth timber on about 7,120 total acres. In addition, Alternative 3 includes commercial thinning of young growth on 2,299 acres using conventional harvesting systems. This alternative would result in 4,101 acres of conventionally harvested clearcuts, which has the highest risk for invasive plant spread, considering harvest prescription and harvest method (described in the Effects from Timber Harvest subsection above).

Alternative 3 would have the most road construction, stream crossings, rock quarry development, and acres of conventionally harvested clearcuts. Consequently, it would have the highest level of risk for invasive plant spread among the alternatives.

### Alternative 4 – Direct and Indirect Effects

This alternative proposes approximately 31 total miles of road construction and reconstruction consisting of 19 miles of reconstruction of stored system roads, 0.2 mile of new system road, and 11 miles of new temporary roads. This alternative also proposes one new stream crossing, and the construction of approximately 3 acres of rock quarries. Effects of these actions are discussed in detail under the preceding road construction effects section.

Alternative 4 includes mostly partial cutting and a lesser amount of clearcutting prescriptions, using conventional (cable and shovel) logging systems and helicopter yarding to harvest old-growth timber on about 4,757 total acres. In addition, Alternative 4 includes commercial thinning of young growth on 1,888 acres using conventional harvesting systems. This alternative would result in 710 acres of conventionally harvested clearcuts, which has the highest risk for invasive plant spread, considering harvest prescription and harvest method (described in the Effects from Timber Harvest subsection above).

This alternative would have the lowest road construction, stream crossings, rock quarry development, and acres of conventionally harvested clearcuts. Consequently, it would have the lowest level of risk for invasive plant spread among the action alternatives.

### Alternative 5 – Direct and Indirect Effects

This alternative proposes approximately 34 total miles of road construction and reconstruction consisting of 17.5 miles of reconstruction of stored system roads, 0.8 mile of new system road, and 16 miles of new temporary roads. This alternative also proposes one new stream crossing, and the construction of approximately 9 acres of rock quarries. Effects of these actions are discussed in detail under the preceding road construction effects section.

Alternative 5 includes mostly partial cutting and a small amount of clearcutting prescriptions, using conventional (cable and shovel) logging systems, as well as helicopter yarding to harvest old-growth timber on about 5,452 total acres. In addition, Alternative 5 includes commercial thinning of young growth on 1,850 acres using conventional harvesting systems. This alternative would result in 1,695 acres of conventionally harvested clearcut, which has the highest risk for invasive plant spread, considering harvest prescription and harvest method, (described in the Effects from Timber Harvest subsection above).

This alternative would have the second lowest amount of road construction, lowest stream crossings, second lowest rock quarry development, and second lowest amount of conventionally harvested clearcuts. Correspondingly, it would have the second lowest level of risk for invasive plant spread among the action alternatives.

### Cumulative Effects

The analysis area for cumulative effects is the project area, as this is where the majority of activities would originate that would cause invasive plant spread and the creation of vulnerable habitats subject to invasion.

Existing foreseeable projects that may contribute to invasive plant spread include the other timber sales, commercial thinning, and other projects (described in Appendix D), resulting in habitat alteration through timber harvesting, road construction, road maintenance, stream crossings and rock quarry development. Effects of these projects would be similar to the effects previously described in the Environmental Consequences section. Microsales are generally located adjacent to existing roads and usually will not require new roads, although they could result in invasive plant spread as a result of altered habitat, habitat vulnerability and associated vectors from project activities. See harvesting effects section and risk assessment (in the Big Thorne Project record) for additional details. Timber sales on State land are expected to occur, as noted in the section at the beginning of this chapter, and result in the construction of 4 miles of additional roads, which could result in the spread of invasive plants.

Habitat alteration and an increase in vectors through road construction, stream crossings, rock quarry development, and tree harvesting would contribute to the cumulative effects of invasive plant spread as a result of the past, present and foreseeable projects in the project area. Cumulative effects due to timber harvesting include effects due to the proposed project, current projects, and foreseeable projects in the project area. Acres of past timber harvest are not included due to the relatively quick regeneration of harvested sites and the low likelihood of invasive plant persistence in old harvest units. Forested areas regenerate rapidly, resulting in dense native vegetation growth and a low likelihood of invasive plant persistence. For this reason, these areas are only temporarily susceptible. For this reason, only acres harvested since the year 2000 are considered to contribute to cumulative effects (approximately 2,355 acres).

These effects are described previously in the Environmental Consequences section and are cumulatively summarized in Table INV-5.

**Table INV-5.** Cumulative Timber Harvesting Impacts

| Alternative | Cumulative Effects - Acres | | | Total |
|---|---|---|---|---|
| | Past Harvest1/ | Big Thorne Harvest2/ | Present & Reasonably Foreseeable Projects3/ | |
| 1 | 2,355 | 0 | 1,046 | 3,401 |
| 2 | 2,355 | 5,120 | 1,046 | 8,521 |
| 3 | 2,355 | 9,419 | 1,046 | 12,820 |
| 4 | 2,355 | 6,645 | 1,046 | 10,046 |
| 5 | 2,355 | 7,302 | 1,046 | 10,703 |

1/ Past harvest since the Year 2000.
2/ Harvest proposed by the Big Thorne Project, including thinning.
3/ Acres calculated based on projects described in the Known Projects Section

Implementation of the Prince of Wales Island ATM (see Transportation Section) on the Thorne Bay Ranger District would slowly reduce the spread of invasive plants where roads are closed or decommissioned, as a result of changing the type of use and maintenance the road receives. These changes would be expected to occur over a period of years, as decreased road use enables native vegetation to colonize the road and out-compete invasive plants or prevents their establishment. Over time canopy closure and native vegetation would out-compete invasive plants. The table below summarizes by alternative the results of implementation of the ATM. With implementation of this plan, there would be 77 miles of open and maintained road in the project area and 83 miles of road open and maintained for OHV use. Motorized trail use would vary by alternative, with Alternative 1 the lowest with 44 miles and Alternative 3 the highest with 47 miles. The highest number of cumulative road miles would result from Alternative 3, followed by Alternatives 2, 5, and 4. The No-action Alternative would have the lowest cumulative effects. The cumulative effects of stream crossings and rock quarries are similar and also summarized in Table INV-6.

**Table INV-6.** Summary of Cumulative Acres in Harvest Units, Road Construction, Number of Stream Crossings, and Acres of Rock Quarry as a result of the Big Thorne Project

| Alternative | Total Acres in Harvest Units 1/ | Total Road Miles 2/ | Number of Stream Crossings 3/ | Acres of Rock Quarries 4/ |
|---|---|---|---|---|
| Alternative 1 | 3,401 | 585 | 1,299 | 585 |
| Alternative 2 | 8,521 | 612 | 1,313 | 612 |
| Alternative 3 | 12,820 | 622 | 1,325 | 622 |
| Alternative 4 | 10,046 | 588 | 1,300 | 588 |
| Alternative 5 | 10,703 | 594 | 1,300 | 594 |

1/ Includes only present (harvest since 2000) and reasonably foreseeable harvesting and that expected from the Big Thorne Project (including commercial thinning); see Table INV-5.
2/ Includes all roads, including State, private, NFS and temporary roads. Includes roads that are existing and those expected from present and reasonably foreseeable projects (5 miles) and the Big Thorne Project.
3/ Includes existing and new project crossings on stream classes 1-3 for open, stored, closed and decommissioned roads
4/ Assumes 1-acre of rock quarry development needed for every mile of road construction. Includes rock quarry acreages from existing and reasonably foreseeable projects, and the Big Thorne Project.

Following is a summary of the cumulative impacts by alternative including the acres harvested, road miles, stream crossings, and rock quarries in the project area.

### *Cumulative Effects of Alternative 1*

For Alternative 1, the combination of past, present and reasonably foreseeable projects within the Big Thorne project area would result in cumulative impacts of 3,401 acres of timber harvest or commercial thinning (including past harvest since 2000), approximately 585 total road miles, 1,299 total stream crossings, and 585 total acres of rock quarries. This alternative would have the lowest amount of timber harvest and the lowest cumulative number of roads, stream crossings, and rock quarries. As a result, it would have the lowest cumulative risk of invasive plant spread.

### *Cumulative Effects of Alternative 2*

For Alternative 2, the combination of past, present, and reasonably foreseeable projects with the Big Thorne project area would result in cumulative impacts of approximately 611 road miles, 1,313 stream crossings, and 611 acres of rock quarries. This alternative would result in 8,521 acres of harvest or commercial thinning (including past harvest since 2000). It would have the second-lowest acreage of timber harvesting/thinning, and the second-highest number of total road miles, stream crossings and acres of rock quarry development, among the alternatives. Due to these disturbances, it would have the second-highest risk of invasive plant spread. The extent of this cumulative effect would be less than that experienced under Alternative 3, but more than under Alternatives 4 and 5.

### *Cumulative Effects of Alternative 3*

For Alternative 3, the combination of past, present, and reasonably foreseeable projects within the Big Thorne project area would result in cumulative impacts of approximately 622 road miles, 1,325 stream crossings, and 622 acres of rock quarries. This alternative would result in 12,820 acres of new timber harvesting or thinning (including past harvest since 2000) and the highest cumulative amount of harvest, road miles, and acres of rock quarry development. Due to these disturbances, it would have the highest cumulative risk for invasive plant spread.

### *Cumulative Effects of Alternative 4*

For Alternative 4, the combination of past, present, and reasonably foreseeable projects within the Big Thorne project area would result in cumulative impacts of approximately 588 total road miles in the project area, 1,300 stream crossings, and 588 acres of rock quarries. This alternative would result in 10,046 acres of timber harvesting (including past harvest since 2000). Of the action alternatives, this alternative would have the second-lowest amount of acreage of new timber harvesting/thinning. However, this alternative would have the lowest cumulative amount of old-growth harvest and the lowest amount of road miles and acres of rock quarry development, and the second-lowest number of stream crossings. Alternative 4 would have a slightly less contribution to cumulative effects on invasive plant species compared to Alternative 5, due to fewer road miles, harvest, and rock quarry development, and considerably less than Alternatives 2 and 3.

### *Cumulative Effects of Alternative 5*

For Alternative 5, the combination of the present and reasonably foreseeable projects with the Big Thorne Project would result in cumulative impacts of approximately 594 total road miles, 1,300 stream crossings, and 594 acres of rock quarries. This alternative would result in 10,703 acres of timber harvesting (including past harvest since 2000). Of the action alternatives, this alternative would have the second-highest cumulative acres of new timber harvest/thinning, the second-lowest cumulative road mileage and rock quarry development, and the lowest number of stream crossings. Primarily due to the lower road mileage, rock quarries, and stream crossings, this alternative would cumulatively have the second-lowest risk of invasive spread among the action alternatives.

## Risk Assessment

The increased risk of high priority invasive plant spread in the project area as result of any of the action alternatives is low to high along roadsides, depending on the alternative. This risk is associated with spread of invasive plant species already in the project area along new and existing system roads. Alternatives 2 and 3 would have a moderate to high increased risk due to the amount of new road construction. Alternatives 4 and 5 would have a low to moderate increased risk associated with the much lower levels of new road construction. With mitigation and monitoring, the risk would be reduced to low for Alternatives 4 and 5 and moderate for Alternatives 2 and 3.

The risk of introduction of new invasive plants, and spread of existing invasive plants into forested areas, other natural habitats, and along temporary roads and landings is low to moderate and short term under all alternatives.  With mitigation and monitoring, the risk would be reduced to low.

For a detailed description of this risk assessment, see the invasive plant risk assessment (Opolka and Fairbanks 2013b) and Invasive Species Resource Report (Opolka 2013b) in the Big Thorne Project record.

# Timber and Vegetation

## Introduction

### Resource Analysis Area

The analysis area for direct, indirect, and cumulative effects for timber and vegetation is the Big Thorne project area.

### Inventory Methods and Units of Measure

Initial project area information was obtained from the Thorne Bay Ranger District GIS library, aerial photos, and Forest Activities Tracking System (FACTS). During the 2010 and 2011 field seasons, a silviculturist and other staff from the Thorne Bay Ranger District performed an inventory of the original unit pool in the project area using walk-through exams and a combination of basal area and fixed area stand exam sample plots, which were recorded at each plot location. Plots were located at a frequency of approximately one per 10 acres or about six plots per proposed harvest unit for units less than 60 acres in size. The basal area plots were utilized to estimate the basal area per acre by species (both live and dead), and the fixed area plots were used to estimate the trees per acre by species in each unit. Volumes were estimated using average volume to basal area ratios for each species based upon whether the majority of the stand was in high, medium or low volume strata. Observations such as stand development stage, stand structure, windthrow potential, insect, disease and decay occurrence, site characteristics, and other information were incorporated into the exam procedure. Observations and plot data for each unit are stored in the Big Thorne Project record. The information gathered by this inventory contributed to development of a site-specific silvicultural diagnosis and logging system feasibility for the proposed timber stands.

### Forest Land Classification

NFS lands are defined by vegetative cover, soil type, and administratively designated land use. This classification scheme is intended to show the amount of land covered by forested vegetation with further divisions to show the amount land capable of timber production (Figure TBR-1).

To be considered suitable for timber management, lands must be determined tentatively suitable for timber management and must be within a LUD that allows timber harvest. For this project, these LUDs are Timber Production, Modified Landscape, Scenic Viewshed, Recreational River, and Scenic River. Although these LUDs allow timber harvest, some acres within each LUD would not be available for harvest due to protections defined in the Forest Plan standards and guidelines for other resources. Some of the protections in the Big Thorne project area include RMAs, over-steepened slopes, and retention of legacy forest structure. Figure TBR-1 shows the land classifications for the 217,679 acres of NFS land in the Big Thorne project area.

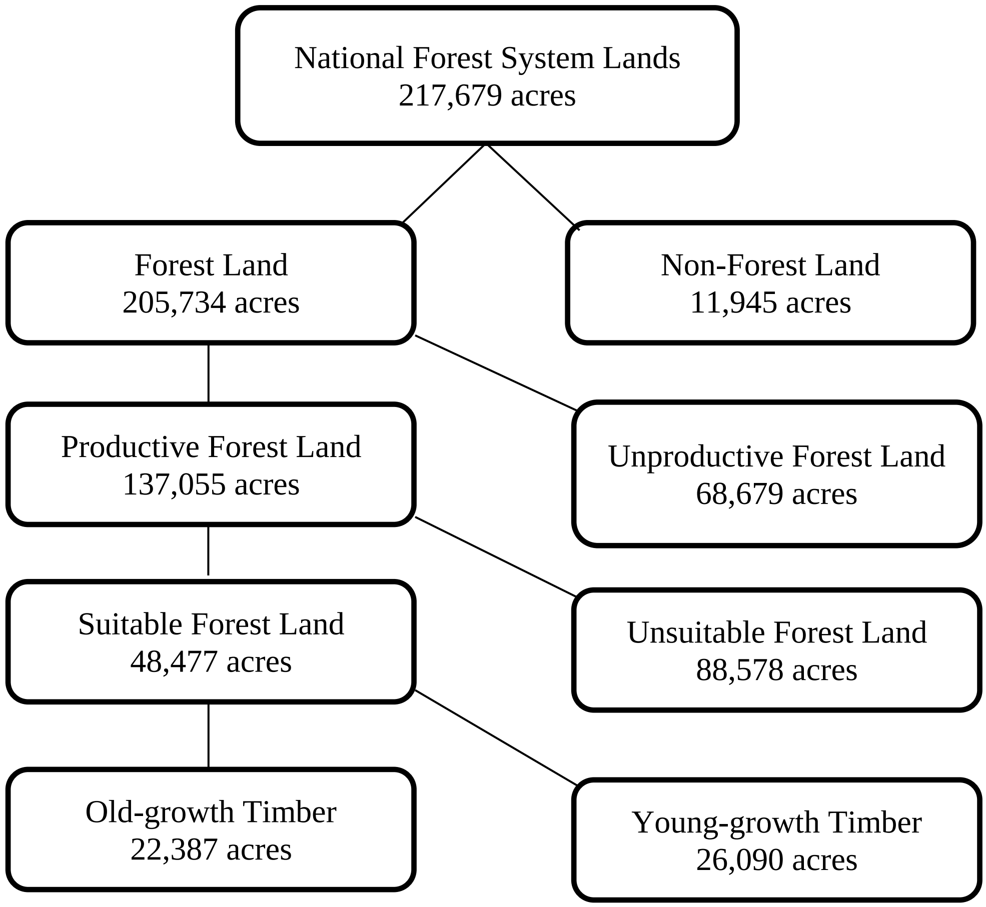


**Figure TBR-1.** Current NFS Land Classifications in the Big Thorne Project Area

### *Non-forest Land*

About 5 percent (11,945 acres) of the NFS land in the Big Thorne project area is classified as non-forest. Non-forest land is land that is biologically unable to support at least a 10 percent tree cover. This land classification includes muskegs, rock outcrops, talus slopes, alpine vegetation, and river systems, among others.

### *Forest Land*

About 95 percent (205,734 acres) of the NFS land in the Big Thorne project area is classified as forest land. Forest land has at least 10 percent tree cover of any size, or formerly had such tree cover and is not currently developed for non-forest use (36 CFR 219.3). Forest land is divided into productive (137,055 acres) and unproductive forest land (68,679).

### *Productive Forest Land*

About 63 percent (137,055 acres) of the NFS land in the Big Thorne project area (67 percent of forest land) is classified as productive forest land. These lands have timber volumes of at least 8,000 board feet per acre or have the potential to achieve this volume and are capable of maintaining that volume. This land is capable of producing 20 cubicfeet per acre, per year of tree growth. Productive forest land includes young-growth stands that have regenerated with conifer species after natural or human disturbance. There are 42,087 acres of young growth originating from harvest, 623 acres originating from natural disturbance, and 94,345 acres of POG. Productive forest lands are further classified as either suitable or unsuitable for timber production.

### *Suitable Forest Land / Suitable and Available Forest Land*

The Forest Plan assigned LUDs that allow timber harvest in areas that were determined to be suitable for timber production. Some land was removed from the suitable timber base due to Forest Plan standards and guidelines within those areas. Appendix A of the Forest Plan describes the process that was used to identify suitable forest land. About 62 percent (85,530 acres) of the productive forest land in the Big Thorne project area is classified as tentatively suitable for timber production. However, only 35 percent (48,477 acres) of the productive forest lands are classified as tentatively suitable and are within LUDs that allow timber harvest; these lands are considered suitable for timber production. Approximately 46 percent of the suitable forest land (22,387 acres) is currently in POG while the remaining 54 percent (26,090 acres) is in young growth.

### *Unsuitable Forest Land*

Unsuitable forest lands are lands that have resource concerns that preclude timber harvest or are in LUDs that preclude timber harvest. Areas with slopes greater than 72 percent that have unstable soils, high vulnerability karst lands, areas within riparian, beach and estuary buffers, and OGRs are examples of forest land classified as unsuitable for timber production. About 65 percent (88,578 acres) of the productive forest land in the Big Thorne project area is classified as unsuitable for timber production. Most of these lands are in POG, but 16,585 acres (19 percent) are in young growth, having been harvested 35-60 years ago.

National Forest System lands within the project area total 217,679 acres; these acres exclude saltwater and non-NFS acres (there are 14,169 acres of non-NFS land within the project area and these acres are not included in Figure TBR-1).

The Big Thorne Project proposes to harvest a maximum of 22 percent (4,962 acres) of the remaining suitable old growth within the project area. In addition, two alternatives for the Big Thorne project area propose different levels of modification to the location of the Old-growth LUDs adding an additional potential harvest of 1,325 acres (in both alternatives) from what is currently classified as Old-growth Habitat LUD in the Forest Plan. Alternatives in the Big Thorne project area also propose commercial thinning harvest on up to about 2,299 acres in young-growth stands when they are 50 years in age and older. None of the young growth is in RMAs or beach fringe; about 83 acres are in Old-growth Habitat LUD. Although this LUD is not considered suitable for timber production, thinning would be for the purpose of improving habitat quality in closed canopy stands and accelerating development of old-growth stand conditions. Combined, the maximum area under consideration for treatment in the Big Thorne project area includes approximately 9,419 acres.

Initially, the IDT identified 20,668 acres of potential harvest units within the Big Thorne project area (see Table TBR-1). These acres included old growth from suitable lands based upon current Forest Plan LUDs, old growth that would be suitable after proposed Forest Plan changes to the OGR LUD in the project area, and young-growth thinning units identified in the project area. Of those original acres, about 9 percent were removed from harvest consideration in order to be consistent with the 2001 Roadless Rule, about 9 percent were removed due to Tongass Timber Reform Act (TTRA) buffers and other riparian buffers, and about 33 percent were removed due to other resource concerns such as soils, timber, economics, Forest Plan legacy requirements, wildlife, and karst. The remaining acres included in the EIS unit pool consist of 7,120 acres that are primarily old growth typical of Southeast Alaska and 2,299 acres of 40- to 60-year-old spruce-hemlock natural regeneration. The primary species in the old-growth and mature timber types are western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), mountain hemlock (*Tsuga mertensiana*), western redcedar (*Thuja plicata*), and Alaska yellow-cedar (*Callitropsis nootkatensis*). The primary species in the young-growth stands are western hemlock and Sitka spruce.

**Table TBR-1.** Original, Eliminated, and Resulting Big Thorne Unit Pool Acres

| Category | Suitable Units (Old Growth) | OGR LUD Units (Old Growth) | Young Growth Thinning (current age 40-60) | Combined DEIS Unit Pool |
|---|---|---|---|---|
| Original LSTA Unit Pool Acres | 13,710 | 3,262 | 3,696 | 20,668 |
| Eliminated due to 2001 Roadless Rule | 1,919 | 0 | 0 | 1,919 |
| Eliminated for TTRA and Other Riparian Buffers | 1,554 | 163 | 228 | 1,945 |
| Eliminated for Other Resource Concerns | 4,442 | 1,774 | 1,169 | 7,385 |
| Resulting Unit Pool Acres | 5,795 | 1,325 | 2,299 | 9,419 |

## *Affected Environment*

### Existing Condition

The project area is a mosaic of coniferous forests in managed and unmanaged conditions, interspersed with muskeg, scrubland, and alpine plant communities. The forests are primarily western hemlock, with a Sitka spruce component and scattered Alaska yellow-cedar and western redcedar. Higher percentages of Sitka spruce are found along streams and other well-drained sites. The understory shrubs are primarily blueberry, huckleberry, and rusty menziesia. Many species of vascular plants, lichens, and mosses occur throughout all habitat types. Forested muskeg with a high percentage of Alaska yellow-cedar occurs throughout the project area. Red alder is found on disturbed sites such as roadsides, landslides, and along stream banks. Muskegs support shore (lodgepole) pine.

#### *Old-Growth Species Composition*

Plant associations are a type of vegetation classification system based on the climax plant community. Stands within a specified plant association are comprised of vegetation with similar species composition and abundance. Plant associations can be used to predict site response to changes caused by management practices.

Most of the proposed harvest areas are a mosaic of two or more plant associations. The plant associations found within each unit are documented in the individual unit prescription and diagnosis form available in the planning record. The species composition of suitable and available lands in the project area, as computed from archived stand exam data is: western hemlock 44 percent, Sitka spruce 24 percent, western redcedar 11 percent, Alaska yellow-cedar 17 percent, and mountain hemlock 4 percent. These percentages are based on the percent net board foot volume of live and dead trees. Although Sitka spruce represents the fewest trees per acre among the listed species, this species has the highest quadratic mean diameter (QMD) and therefore represents the largest trees.

### *Old-Growth Volume Strata*

The POG acres are stratified into high, medium, and low volume strata. Volume strata were determined by using the GIS volume class layer and combining it with GIS soils and aspect information. Gross volume (MBF) per acre by volume strata for the project area was determined by the re-aggregation of stand exam plot data by volume strata (Table TBR-2). The following parameters define each volume strata:

**High Volume Strata**—Areas within timber inventory volume classes 5, 6, and 7 on non-hydric soils, and on hydric soils with slopes greater than 55 percent.

**Medium Volume Strata**—Areas within timber inventory volume classes 5, 6, and 7 on hydric soils with slopes less than or equal to 55 percent; areas within timber inventory volume class 4 that are either on non-hydric soils, or are on hydric soils greater than 55 percent.

**Low Volume Strata**—Areas within timber inventory volume class 4 that are on hydric soils with slopes less than or equal to 55 percent.

**Table TBR-2.** Gross Volume per Acre by Volume Strata

| Volume Strata | Average Gross Volume per Acre (MBF/Acre)1/ | Suitable Project Area Acres |
|---|---|---|
| Low | 31.78 | 5,549 |
| Medium | 39.50 | 6,522 |
| High | 44.67 | 10,316 |
| All Suitable POG2/ | 39.97 | 22,387 |

1/ Gross volume for both live and dead trees based on re-aggregated stand exam plot data.
2/ This is a weighted average based on the suitable project area acres.

### *Young-growth Stands*

Young-growth stands in the project area are variable, depending on age. Young growth in the project area originated primarily from even-aged harvesting. Large-scale even-aged timber harvest in the project area began in the late 1950s and peaked in the 1960s (Figure TBR-2). Young growth stand conditions that influence readiness for commercial thinning vary depending on stand age, site productivity and past treatments. The stands being considered for commercial thinning in this project were harvested in the 1960s or earlier.

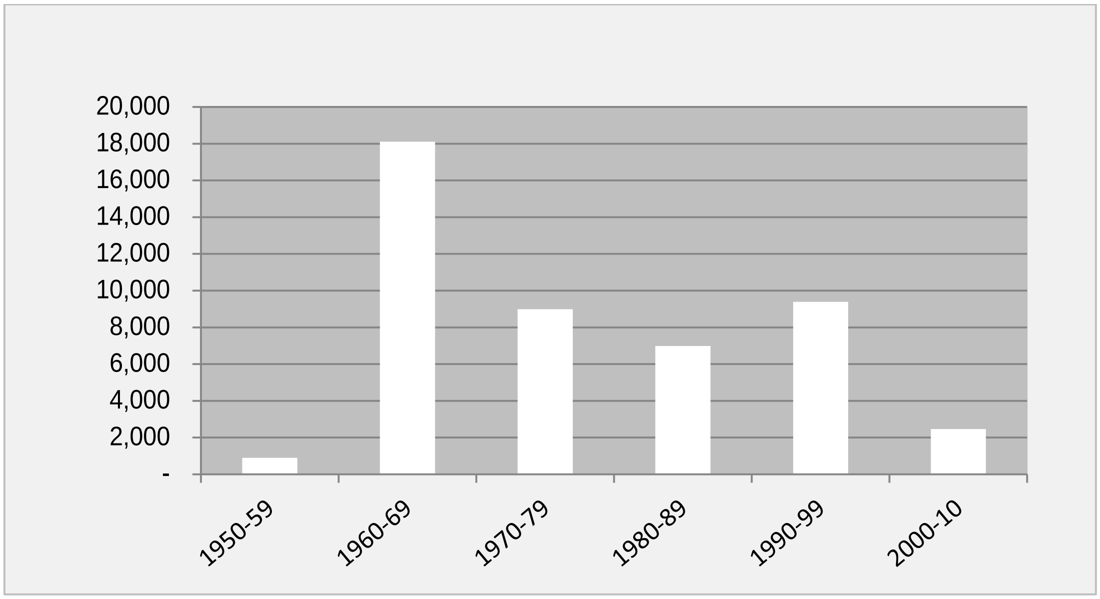


**Figure TBR-2.** Big Thorne Project Area Harvest Acres by Decade

These stands are dominated by either western hemlock or Sitka spruce, and contain lesser amounts of western redcedar, red alder, mountain hemlock, and Alaska yellow-cedar. Many of the older stands have been pre-commercially thinned and these stands currently contain fewer trees per acre and larger average diameters. Average net volume for young-growth stands at age 50 ranges from about 9 to 13 MBF per acre on medium productivity sites and from about 13 to 21 MBF per acre on high productivity sites.

## Forest Health and Natural Disturbance

### *Dwarf Mistletoe*

The occurrence of dwarf mistletoe in late successional western hemlock stands is widespread throughout Southeast Alaska, including the Big Thorne project area. The small-scale (canopy gap) disturbance pattern in the old forests of coastal Alaska favors the short-range dispersal mechanism of hemlock dwarf mistletoe and may explain the common occurrence of the disease in this area (USDA Forest Service 2009b). Dwarf mistletoe presence was recorded in all proposed harvest areas in the Big Thorne project area wherever western hemlock was present. There were 126 units in the current unit pool that were rated low, 69 rated moderate, and 43 rated high.

Dwarf mistletoe reduces the vigor and growth rate of hemlock resulting in low quality timber. Cankerous swellings often occur at the point of infection on limbs and main stems. These cankers offer an entrance for wood-destroying fungi, which can lead to heart and stem decay.

Clearcut harvesting is an effective method of controlling hemlock dwarf mistletoe if reduction or eradication of the disease is consistent with management objectives (USDA 2001c). Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the potential reduction in timber volume and value from hemlock dwarf mistletoe under some of these silvicultural scenarios. Substantial reductions to timber are only associated with high disease levels, however. High levels of hemlock dwarf mistletoe will only result if numerous large, intensely infected hemlocks are well distributed after harvest (USDA Forest Service 2007b: p. 44). In some situations, the Big Thorne Project proposes to partially harvest stands with high mistletoe ratings in order to mitigate the effects of even-aged harvest on wildlife and watershed resources, economics, and scenery.

### *Decay Fungi*

Decay caused by heart and root-rotting fungi is probably the greatest single cause of disease-related timber volume loss in Alaska (Laurent 1974), and such damage is present within the Big Thorne project area. Approximately one-third of the old-growth timber volume in Southeast Alaska is defective, largely due to heart-rotting fungi. Heart decay causes considerable damage in all conifer species in Southeast Alaska, but is more common in western hemlock, mountain hemlock, and Sitka spruce (USDA Forest Service 2009b).

Decay centered in the boles of trees can weaken the support structures, thereby leading to breakage. As the broken portion of the tree falls to the forest floor, it may wound adjacent trees and lead to eventual infection of the damaged trees. This is a continual process in old-growth forests in Southeast Alaska and contributes to the diversity of the stand structure. This process decreases the health and windfirmness of the stand, leading to decreased ability to provide a future timber supply and therefore reducing the stand's ability to reach its desired condition. The volume growth rate in most old-growth units in the Big Thorne Project is predicted to currently be either offset or exceeded by decay.

Decay-causing fungi are present in all stands within the project area. There were 61 units in the current unit pool that were rated high for the occurrence of decay fungi, 167 units that rated moderate and 10 units rated low. A high rating was given when it appeared that the average defect per tree in the unit would exceed 31 percent, or what is considered the average defect within live old-growth trees in Southeast Alaska (USDA Forest Service 2009b, p.159). A moderate rating was given when it appeared that the average defect would be about 31 percent. A low rating would have been given if a unit was determined to be somewhat less than 31 percent. A low rating would usually only be noted where a large amount of the live trees in the stand are young.

### *Wind Disturbance*

Wind is the major natural disturbance agent affecting forest dynamics in Southeast Alaska. It causes the loss of trees, singly or in groups, and recycles forest stands and maintains and renews the forest ecosystem. However, timber harvest has the potential to exacerbate the rate of windthrow in adjacent forest stands. The severity and frequency of wind disturbance is determined by many interrelated factors. These influencing factors include tree size and vitality, tree height-diameter ratio and crown size, slope, aspect, soil characteristics, stand composition, canopy structure and the characteristics of the surrounding topography, which may influence wind flow (Harris 1989).

Existing windthrow within a stand is an important indicator of windthrow hazard. Certain conditions are indicators of windthrow hazard for individual trees as well as stands. The windthrow history of a stand can be determined from field observations. These conditions, as well as a stand's windthrow history, were used to evaluate the windthrow hazard for each unit.

In the Big Thorne project area, high windthrow hazard was generally found in areas with exposure due to topography, vortex winds or adjacent logging. High ratings were often given to units with exposure to the southeast winds off Clarence Strait. There were 63 units rated high for windthrow. These stands were generally located where high wind speeds and turbulence are likely to occur and where the stand structure, composition and tree form make the stand more susceptible to wind damage. Units that were more topographically sheltered from direct storm winds and had less evidence of past wind damage were rated moderate for windthrow. There were 151 units that rated as moderate. Stands rated moderate have either factors that contribute to poor anchorage with low wind force, moderate resistance to overturning and moderate wind force or good resistance to overturning and high wind force. There were 24 units that were well sheltered with little evidence of past wind damage. These units were rated low.

### *Alaska Yellow-cedar Decline*

Alaska yellow-cedar decline is a disease causing considerable mortality in Southeast Alaska. Mortality can be in small patches or can cover expansive areas. Affected trees may die quickly (in 2 to 3 years), or slowly over 15 years or longer with crowns progressively thinning.

Yellow-cedar decline is characterized by extensive tree deaths occurring in and around open canopy forests on poorly drained soils. The distribution of yellow-cedar decline suggests climate as a trigger with the presence of snow as the key environmental factor. Researchers currently believe this mortality is the result of a combination of factors centered around freezing injury to roots resulting from low spring snow pack and poor soil drainage. A change in climate about 5,000 years ago may be considered a predisposing factor as a shift to a cool and wet climate initiated peat development and poorer drainage (Hennon et al. 2012).

The 2010 Forest Health Conditions in Alaska report indicates that the Big Thorne project area has cumulative yellow-cedar decline mainly in higher elevations with the heaviest concentrations on the west half of the project area and a strip along the eastern coastline. The walk-through stand exams within the Big Thorne unit pool indicate the heaviest concentrations south of the Thorne Bay to Control Lake highway. Areas with extensive decline are typically within lower productivity forest lands on slopes less than 25 percent. These areas have low site index, poor soils, and low timber volume per acre, which makes the majority unsuitable for timber production (USDA Forest Service 2008d).

The primary ecological effects of yellow-cedar decline are changes in stand structure and composition. Snags are created, and succession favors other conifer species, such as western hemlock, mountain hemlock and western redcedar. In some stands, where cedar decline has been ongoing for up to a century, a large increase in understory shrub biomass is evident. Nutrient cycling may be altered, especially with large releases of calcium as yellow-cedar trees die. The creation of numerous yellow-cedar snags is probably not particularly beneficial to cavity-nesting animals because its wood resists decay, but the snags may provide branch-nesting and perching habitat. On a regional scale, excessive yellow-cedar mortality may lead to diminished cedar populations (but not extinction), especially considering this species' low rate of regeneration and recruitment in some areas. These losses may be balanced by yellow-cedar thriving in other areas, such as higher elevations and parts of its range to the northwest. Alaska yellow-cedar is preferred deer browse, and deer may significantly reduce regeneration in locations where spring snowpack is insufficient to protect seedlings from early-season browse (Forest Health Report 2012, p. 59–64).

Alaska yellow-cedar decline is estimated to be occurring on about 40,000 acres in the Thorne Bay Ranger District on Prince of Wales Island, an increase of approximately 5,500 acres from the 2004 survey. The cumulative mapping of yellow-cedar decline indicates around 11,000 acres within the Big Thorne project area alone as of 2010 (Forest Health Reports 2004-2010). Current PCT activities in the Big Thorne project area and across Prince of Wales Island are favoring the retention of yellow-cedar. This is expected to increase the amount of yellow-cedar in future stands.

## *Environmental Consequences*

Direct, indirect, and cumulative effects for timber and vegetation resources are estimated using quantifiable measures or indicators for actual effects, as appropriate. The analysis area for direct, indirect, and cumulative effects is the project area. The level (magnitude and intensity) of effects are also assessed in terms of how widespread the effect is likely to be and how long it is likely to last. The effects of timber harvest on forest vegetation vary by silvicultural prescription and the number of acres harvested by prescription. The following provides a discussion of effects related to the various components of the timber resources including stand structure, forest health and productivity, regeneration and species composition, and windthrow risk.

### Silvicultural Systems and Prescriptions

Silvicultural systems are used to manage, harvest, and re-establish stands of forest trees for the purpose of meeting pre-determined objectives. Silvicultural systems have been developed to produce more valuable commercial timber at a faster rate, maintain wildlife habitat, and either maintain or enhance scenery values. No single silvicultural system for a forest stand can be used to achieve all the desired combinations of amenities and products. Instead, a variety of treatments applied over a project area results in a mosaic of stands for different uses. Through the harvest of timber or other treatments, such as thinning or pruning, existing stands are altered by proposed management actions.

The Forest Plan standards and guidelines and USDA FSM 2400 (Timber Management) provide detailed information about three silvicultural systems recommended for the Tongass National Forest. Even-aged management results in the conversion of mature stands to faster growing stands of a single age. On the Tongass it generally is implemented as clearcutting, clearcutting with reserves, or seed tree. Even-aged clearcuts can be up to 100 acres in size or larger if certain circumstances are met. Two-aged management results in a seedling stand with varying levels of older-aged residual trees. On the Tongass, it includes clearcutting with reserves, patch clearcutting, and seed tree with reserves. Under two-aged management any single age harvest entry can account for no more than 85% of the stand area. Uneven-aged management results in a stand of younger trees interspersed with older trees, either in clumps or distributed across the stand. Uneven-aged systems include single-tree selection and group selection. Harvested openings are generally restricted to two acres or less.

The post-harvest conditions of the forest stand for all systems are dependent upon the existing plant community, the retained canopy structure, and advanced regeneration. Species composition is monitored to ensure that the mix of species is roughly the same as expected on the existing site.

The Big Thorne Project uses even-aged management, two-aged management, and uneven-aged management silvicultural systems. The criteria used to select the appropriate silvicultural system for each unit include the following:

- Forest Plan LUDs;
- Standards and Guidelines requirements
- Operational feasibility (possible logging systems)
- Economics
- Windthrow hazard (the presence of tree and stand attributes determining windthrow potential)
- Stand conditions (diseases and decay fungi)
- Regeneration potential

In addition, the following site-specific objectives were considered as well:

- Obtaining favorable timber sale economics and logging feasibility
- Retaining old-growth characteristics to maintain biodiversity
- Protecting scenery, wildlife habitat, soil, or watershed, characteristics
- Maximizing wood-fiber production for future human use

Silvicultural prescriptions provide guidance through the entire rotation including natural regeneration certification, thinning, and monitoring. A complete silvicultural prescription has been written for each unit selected for harvest. These are designed to address site-specific conditions within the treatment area. For example, RMAs with concerns for watershed stream channel stability and windthrow potential have been identified and would have trees retained in expanded reasonable assurance of windfirmness (RAW) buffers as needed. The size and configuration of the RAW buffer would be determined during unit layout by an interdisciplinary team as identified in the unit cards. In some cases, RAW buffers are accomplished through unit design or silvicultural system. Another example is the prescription of wind firmness for visual buffers that are to be established in clearcut units along visual priority routes.

Silvicultural prescriptions sometimes vary by alternative in order to address the different management objectives being analyzed in the range of alternatives. These differences in alternatives are driven by issues identified during the scoping process for this project. For example, a harvest unit may be planned for even-aged management under an alternative emphasizing the maximum timber harvest from the project area or uneven-aged management under an alternative using helicopter yarding methods to minimize road impacts and retain forest structure in alternatives emphasizing wildlife or watershed protection. In most cases, the silvicultural prescription for a treatment area remains the same between the different alternatives. Table TBR-3 shows acres by silvicultural system and the regeneration method for each alternative.

**Table TBR-3.** Silvicultural System Acres by Alternative and Yarding System

| Silvicultural System and Alternative | Number of Units[1/] | Acres Treated | | |
|---|---|---|---|---|
| | | Total | Cable or Ground | Helicopter |
| **Even-Aged Management:** | | | | |
| Alternative 2 | 134 | 3,915 | 3,216 | 699 |
| Alternative 3 | 188 | 4,938 | 4,101 | 836 |
| Alternative 4 | 46 | 982 | 710 | 272 |
| Alternative 5 | 98 | 2,453 | 1,695 | 758 |
| **Uneven-Aged Management:** | | | | |
| Alternative 2 | 49 | 1,205 | 0 | 1,205 |
| Alternative 3 | 79 | 2,182 | 0 | 2,182 |
| Alternative 4 | 92 | 3,441 | 0 | 3,441 |
| Alternative 5 | 85 | 2,999 | 0 | 2,999 |
| **Two-Aged Management:** | | | | |
| Alternative 2 | 0 | 0 | 0 | 0 |
| Alternative 3 | 0 | 0 | 0 | 0 |
| Alternative 4 | 10 | 336 | 328 | 8 |
| Alternative 5 | 0 | 0 | 0 | 0 |

1/ Note that some units have more than one prescription.

### *Even-aged System*

Under this system, clearcutting would be prescribed and all or the majority of the merchantable trees would be harvested. The objectives are to create a fast-growing stand of trees that are free from disease to maximize wood fiber production, and provide favorable timber sale harvest economics and logging feasibility. Stands would regenerate into a mostly single-aged stand.

Areas where merchantable-sized trees are retained for resource protection requirements are generally external to final cutting unit boundaries or are along stream zones that protrude into the cutting unit. Reasonable Assurance of Windfirmness (RAW) buffers may also be applied to unit edges or stream and visual buffers that are determined to be at risk for wind damage after harvest.

VCUs that have had concentrated past timber harvest activity and are at risk for not providing the full range of Forest Plan matrix functions are subject to the Legacy Standard and Guideline. These VCUs are identified by the Forest Plan. The Big Thorne project area includes seven VCUs with both proposed harvest and legacy requirements, out of 15 total VCUs with proposed harvest in the project area. In Legacy Forest Structure VCUs, harvest units with openings that are larger than 20 acres are required to leave 30 percent of the original unit opening size, based on the LSTA boundary prior to field verification, in legacy forest structure. Structure left inside of the unit for other resource concerns, excluding TTRA buffers, can be counted towards the 30 percent retention requirement (Forest Plan, page 4-90).

Legacy retention areas were identified and allocated in areas that were subject to other resource concerns where possible. RMAs, probable RAW areas, areas with unstable soils, and visual buffers were often identified as legacy. Areas with high wildlife habitat values, sensitive plant populations, and areas with higher logging difficulty and cost were also allocated to meet the legacy forest structure retention requirements. Adjustment to the planned legacy locations may occur during implementation to best implement multiple objectives.

The amount of legacy required by unit was determined based on the potential even-aged opening that might be created regardless of unit boundaries. The Forest Plan states to base legacy calculations on the original LSTA before field verification. In the Big Thorne Project, the original LSTA units, units added during field reconnaissance, and units proposed during alternative design (OGR modification units) often abutted one another. To meet the intent of the Forest Plan in cases where multiple units less than 20 acres adjoin and create a single opening exceeding 20 acres, legacy acreage requirements are based on the potential opening created by the combination of adjoining units. The location of legacy could be placed anywhere within or adjacent to the combined opening including adjacent areas determined during field reconnaissance as unsuitable for harvest so long as they were consistent with Forest Plan direction on page 4-90.

Uneven-aged units (partial cuts) do not require legacy because no opening greater than 20 acres is created. In cases where part of the unit is partial cut, the other clearcut and the clearcut opening exceeded 20 acres, legacy would need to be applied consistent with the Forest Plan standards and guidelines. Although partial-cut areas (both 50 and 25 percent retention prescriptions) would retain old-growth characteristics, the partial harvest part of the unit was not used to meet the retention for the legacy forest structure standards and guideline.

Within even-aged harvest areas, natural regeneration is expected to be abundant and represent approximately the original species composition of the stand. Additional silvicultural treatments that follow harvest may include tree planting, pre-commercial thinning, and pruning. These treatments can be used to influence species composition, increase individual tree growth, promote wood quality and enhance wildlife habitat. These activities will most likely be completed between 15-35 years after harvest.

NFMA regulations provide that 100 acres is the maximum size of created openings allowed for the forest types of coastal Alaska, unless specific conditions exist (see Timber and Silviculture Resource Report; Barnhart and Hitner 2013a). The 2008 Forest Plan, page 4-72, defines these conditions. With Forest Supervisor approval, where it is determined by environmental analysis that exceptions to the size limit are warranted, the actual size of openings may total 150 acres if increased unit size will produce more desirable benefits.

There are no proposed openings in the Big Thorne project that exceed 100 acres. Since the Draft EIS, modifications to unit 71 due to refined stream mapping have reduced the planned unit size below 100 acres.

<u>Justification for Clearcutting</u>: Even-aged clearcutting is being used in the Big Thorne project area because it is the optimum system to address existing stand conditions and

growth trajectories that are not on track to meet the desired future condition. Even-aged management to precludes or minimizes the risk of post-harvest windthrow, promotes natural regeneration, minimizes logging damage, and minimizes defect and disease in the future stand to the maximum extent possible (Forest Plan, page 4-72). Even-aged management allows for the planting of yellow-cedar on well-drained, cooler sites where the species is expected to be resistant to decline. Follow-up treatments such as pre-commercial thinning will help yellow-cedar to compete with faster growing species such as hemlock and Sitka spruce on these sites.

### *Uneven-aged System*

This prescription usually involves more intensive management than even-aged prescriptions. There is no final rotation age as in even-aged systems but instead regular, periodic entries designed to maintain three or more distinct age classes and a range of diameter classes in a reasonably well dispersed manner across the stand. This results in a stand of high structural diversity due to the high variability in tree sizes and individual tree characteristics. Trees may be removed individually, or in small groups generally 2 acres or less in area. The goal of uneven-aged management is to economically harvest a percentage of the stand while retaining timber for future economically viable and sustainable entries. The next harvest under uneven-aged management would likely be in 50 to 100 years. This prescription would regenerate an uneven-aged stand (a stand with at least three age classes) by partial harvest in areas specified for this prescription. This silvicultural system is the least effective for reducing the distribution of and minimizing the loss of timber volume associated with dwarf mistletoe infection and decay fungi.

Single-tree selection is used in units that have an uneven-aged management prescription and are utilizing a helicopter logging system. Helicopter yarding has been proposed to reduce road construction and associated costs, reduce the impact harvest activities might have on watersheds and wildlife, and also meet objectives for scenery. Uneven-aged management would be achieved by leaving either approximately 50 or 75 percent of the setting pretreatment basal area, based on standing live trees left uncut. Healthy, young trees in the intermediate crown class would be a priority for retention to promote economic future entries. Older trees with low timber, but high wildlife value would also be a priority for retention. The canopy gaps and disturbance created by harvest of the remaining trees would promote new tree regeneration to facilitate future harvest entries as well as promote the growth of understory plants important for wildlife. A retention level of 75 percent is used in units that were identified as having particular windthrow, wildlife, or visual concerns. A retention level of 50 percent was used in units with wildlife or visual concerns, but not requiring the higher level of retention. Future entries would continue the process of developing additional age classes. The next entry would likely occur in 50 years for units with 75 percent retention, and 100 years for units with 50 percent retention. This would allow the intermediate age class to develop into mature trees and provide for another economical harvest. The silvicultural prescription would maximize the flexibility of helicopter yarding to allow for the removal of a higher percentage of more economically valuable trees, while retaining a higher percentage of trees that have higher value for wildlife, or smaller diameter trees that would be more economically valuable in the future.

### *Two-aged Management*

Two-aged management results in stands that have two distinct cohorts separated in age by more than 20 percent of the stand rotation age. This stand structure results naturally from stands completely regenerated after two distinct disturbance events. In order for a harvest to be considered two-aged, at least 15 percent of the original standing green tree basal area must remain after harvest. These trees can be grouped for operational and environmental concerns or be evenly distributed across the stand. If trees are grouped, the groups must be distributed somewhat evenly across the stand.

In the Big Thorne Project, the objective of this prescription is to maintain and manage for two-aged stand structure to meet wildlife objectives in Alternative 4 while allowing for better economic and operational feasibility than uneven-aged management. This prescription would harvest up to 40 percent of the unit area in this entry using patch clearcuts up to 5 acres in size well distributed throughout the stand. Patches should be located so that the residual stand is not isolated from harvest in the future. The openings created will result in regeneration that will constitute a second age class within the stand. Natural regeneration is expected to be abundant and represent approximately the original species composition of the stand. Additional silvicultural treatments that follow harvest may include tree planting, pre-commercial thinning, or pruning. These treatments can be used to influence species composition, increase individual tree growth, promote wood quality, and enhance wildlife habitat. These activities will most likely be completed between 15 and 35 years after harvest.

The second harvest entry into the stand would occur in about 40 years or at a time when the young growth from the first harvest has been pre-commercially thinned and the slash from that treatment does not limit wildlife movement.

Two-aged management maintains habitat connectivity for wildlife and can be easily integrated into the small sale program.

The risk of mistletoe infestation in the young cohort will be significantly decreased in comparison to uneven-aged management, but will be slightly higher than with even-aged management because of the increased edge resulting from smaller openings. Other diseases and defects would be reduced similar to even-aged units.

Two-aged management can improve sale viability for the timber purchaser by allowing for larger harvest areas than uneven-aged management particularly where cable or ground based logging systems are appropriate. The treatment meets objectives for maintaining wildlife travel ways across the unit by maintaining 60 percent of the stands area in undisturbed condition. Harvest openings should be located to balance wildlife needs while creating an economical sale opportunity. Openings must also be planned so that opportunities for the next harvest entry are not forfeited.

Layout, sale preparation, and administration costs are greater than with even-aged management due to the restricted opening size but will be much less than with uneven-aged management where trees may need to be marked or otherwise approved prior to cutting.

**Intermediate Treatments – Young-growth Units**

Approximately 3,700 acres of young-growth stands within the Big Thorne project area were considered for treatment and about 2,300 acres are proposed for intermediate commercial thinning treatments. All of these proposed units are anticipated to be age 50 or older by the time commercial thinning treatments occur. The objectives of these treatments are to improve stand composition, health, value, and growth. Stand value includes both wildlife habitat value as well as future timber value. The objectives of the intermediate treatments will vary depending upon where they fall in the landscape (high-value deer winter range, or upper slopes). No treatments are being proposed in the RMA and beach fringe. Logging system capabilities will also be a consideration when selecting the intermediate treatment prescription for a stand (ground, uphill cable, or downhill cable). No helicopter logging is proposed due to the high logging costs, and subsequently poor overall economics. Timber volume removed from areas available for timber harvest during these treatments will count towards the allowable sale quantity (ASQ). An exception is 50 acres of thinning under Alternative 3 and 81 acres of thinning under Alternative 4 that would occur in Old Growth Habitat LUD. The volume derived from OGRs would not contribute to the ASQ.

The timing of the majority of the young-growth treatments most likely will be during the second half of the implementation of the Big Thorne Project. The approximate 5-year delay in timing will 1) allow the stands to continue to grow, which will increase thinning removal volumes and improve thinning economics; 2) allow the industry time to gear up with equipment suitable for completing the thinning treatments; and 3) allow more time for small log markets to develop for local utilization of the wood.

Export market conditions could have a significant effect on the economics of young-growth treatments. Export markets were fairly strong in 2011, and are expected to persist with fluctuations into the future. The conditions of these markets at the time of implementation could greatly impact the young-growth treatments at that time. The development of more domestic small log markets could reduce some of the dependence on export, and serve to stabilize the long-term market conditions.

The management goal of young-growth treatments in the Big Thorne project area is to produce an industrial wood supply while improving wildlife habitat in treated stands, improve stand growth and vigor, and aid in the transition to young-growth focused equipment and markets. The removal of an industrial wood supply would help meet the timber supply objectives of this project, as well allow value to be captured from wood lost to mortality. The density of trees in the treated young-growth stands would be reduced by uniform or systematic thinning. The resulting stands with more-open canopies and more-widely spaced conifers would be healthy and growing at optimum rates to produce forest products and more-abundant and diverse understories, providing improved winter forage conditions for deer. Thinning would help to reduce the homogeneous stand structure, and to place stands on a trajectory to more closely mimic historic conditions. These treatments would create healthier stands that would have more-consistent stand growth, and would allow for more long-term flexibility in wood supply. The alder component would be minimal, but would be present (until succession converts it to conifers) for habitat diversity; conifers would be released where they are being suppressed.

It is desired that at the end of the planned rotation, stands would be in a condition that regeneration harvests using even-aged, two-aged, or uneven-aged silvicultural systems are feasible and appropriate. Stands should have live crown ratios of 30 percent or higher and height-to-diameter ratios of less than 90 in order to be suitable for partial cutting. In addition, it is desired that the stands mature at different rates or have flexible rotation lengths so that harvests can be spread out and contribute to an even-flow, long-term sustained yield. This would also contribute to a greater mix of age classes and deer forage conditions following the next rotation.

The IDT has identified two different types of intermediate treatments to be conducted in project area young-growth units: a uniform crown thin and a systematic thin. Unit-level silvicultural prescriptions are being developed and will be approved by a Region 10 Forest Service–certified silviculturist to meet the objectives identified by the IDT.

### *Uniform Crown Thin Treatment*

Young-growth units planned for this treatment will be at least 50 years of age at the time of the treatment. The objectives of these treatments are to:

- Increase diameter-growth rate of remaining crop trees.
- Create temporary canopy gaps to increase light to the forest floor and promote crown expansion.
- Improve tree characteristics that promote windfirmness possibly allowing future partial harvests.
- Reduce the effects of stem exclusion stage on wildlife winter forage and habitat.
- Remove poor quality trees from the upper and middle crown to favor the best codominant and dominant trees.
- Provide a volume of merchantable product in a manner that is operationally and economically feasible.

Logging systems used for this treatment will be ground-based and cable thinning. The majority of the cable thinning will be uphill yarding with narrow skyline corridors cut to a width between 12 and 16 feet. This treatment is only used in downhill cable yarding settings where full suspension of the logs can be achieved, which occur in Units 550 and 551.

The uniform thin treatment is being used with a “crown thinning” treatment where most cut trees will consist of poor quality trees from the middle and upper crown. High-quality dominant and codominant trees will be retained with the exception of trees that need to be removed for yarding corridors and skid trails. In general, neither Sitka spruce nor western hemlock would be favored and the spruce/hemlock leave trees would be the most vigorous individuals. These treatments would result in stands which typically have between 100 and 135 trees per acre that are 8 inches diameter at breast height and larger.

Skips or thickets will be left where logging system difficulties occur, in portions of stands where windthrow risk is expected to be unacceptable after thinning, and in any areas where wildlife dens or nest sites are found. Gaps might occur where cable corridors come together at landings or other areas where extra room is needed to facilitate yarding or to meet wildlife or other objectives.

### *Systematic Thin Treatment*

Young-growth units planned for this treatment will be at least 50 years of age at the time of the treatment. The objectives of these treatments are to:

- Increase diameter-growth rate of remaining crop trees.
- Create side lighting and temporary canopy gaps in leave corridor to increase light to the forest floor and promote crown expansion.
- Increase stand diversity by creating early seral conditions in cut corridors.
- Provide a volume of merchantable product in a manner that is operationally and economically feasible.
- Remove poor quality codominant and dominant trees.

Although uniform thinning is the preferred treatment, systematic thinning may be used to reduce residual tree damage, allow operational feasibility, or reduce treatment costs. Systematic thinning would primarily be used in cable settings with downhill yarding that are unable to achieve full suspension. Systematic thinning for this project would remove all merchantable trees within a 20- to 60-foot-wide corridor. The corridor width would depend on operational feasibility, visual concerns, and/or windthrow risk. Where visuals or windthrow are of concern, harvested corridors may be limited to a width of 20 feet. A 60- to 120-foot-wide corridor would be retained between each harvested corridor. The retention corridor would be thinned where operationally feasible. Typically the trees removed from the leave areas would be within 50 feet of the edge of a corridor cut and the cut trees would consist of primarily low-quality codominant and dominant trees. At least approximately 50 percent of the setting pretreatment basal area would be retained, including what is removed in the corridors.

The density of trees in these young-growth stands would be reduced by some thinning, but primarily by corridor cutting. The resulting stands, with more-open canopies and more-widely spaced conifers, would be healthy and growing at optimum rates to produce forest products, and would produce more abundant and diverse understories providing improved winter forage conditions for deer.

## Direct and Indirect Effects on Forest Structure

### *Alternative 1*

No new harvest activity would occur under Alternative 1. Old-growth stands would remain in a predominantly old-growth condition. Small-scale, frequent disturbance events resulting from disease and decay would continue in these stands. At some point in the future it is expected that some stands in the project area would experience larger-scale damage from a severe storm event, leading to the regeneration of the stands in what would likely be a two-aged or possibly, in an extreme case, an even-aged condition.

No commercial thinning would occur in young-growth stands. Based on stand modeling, young-growth stands without commercial thinning, and particularly those without PCT treatments, would grow through a period of extended stem exclusion before gradually developing a more complex stand structure where understory plants return. Without commercial thinning, young-growth stands will be prone to develop tall thin trees with short crowns that have little weather resistance, limiting future rotational harvest options to primarily the even-aged system. The Culmination of Mean Annual Increment (CMAI) is estimated to be reached at 95 to 105 years old for stands with no previous PCT, and at approximately 120 years old for stands that had previous PCT. In most stands where commercial thinning does not occur, stem exclusion structure would dominate most of the entire rotation. Untreated stands will reach CMAI at a younger age.

This alternative would not meet many of the young-growth stand structure objectives. Stands would remain in a relatively homogeneous stand structure, and there would be no opportunity to modify the conditions to achieve a more-diverse landscape that more closely mimics historical stand structure. Leaving the young-growth stands in their current state would also cause diminished productivity and stand health, and decrease the flexibility for future timber supply and harvest options.

### *Alternatives 2, 3, 4, and 5 Old-growth Harvest*

The structure of the forest would be changed by timber harvest under all of the action alternatives. The change would vary by alternative based on the silvicultural prescription and the number of acres harvested.

**Even-aged Management:**

Where even-aged management is prescribed, harvest would result in the creation of relatively homogenous young-growth stands primarily without any older residual trees present within the boundary. The new stands would naturally grow through a number of structural changes in the future, beginning with a brushy stage where tree regeneration is becoming established and understory plants flourish. This stage would be followed by a period of stem exclusion where inter-tree competition shades out the understory. After that the stand would enter a stage where tree mortality opens growing space and an understory, as well as some old-growth characteristics return. The time that any young-growth forest spends in any structural stage would be dependent on the natural growing capability of the land and any future treatments that are applied, such as thinning.

**Uneven-aged Management:**

Where uneven-aged management is prescribed, numerous residual trees would be left, mainly dispersed across the stands. Small openings, up to 2 acres in size, may occur. The number of trees would depend on the amount of retention. Retention of 50 percent of the live basal area is planned for low and moderate wind risk areas. Retention of 75 percent live basal area is planned for high windthrow potential stands, as well as some stands with wildlife or scenery concerns. There is no final rotation age as in even-aged systems but instead regular, periodic entries designed to maintain three or more distinct age classes and a range of diameter classes in a reasonably well dispersed manner across the stand. This results in a stand of high structural diversity due to the high variability in tree sizes and individual tree characteristics. The next harvest under uneven-aged management would likely be in about 50 to 100 years.

In the 50 percent retention areas, the stand structure would be expected to change from old-growth to a structure similar to what is naturally seen when stands are transitioning between understory re-initiation and old growth. The understory re-initiation stage is the structural stage just before a naturally developing stand attains true old-growth structure (Oliver and Larson 1996, p.259-275). These stands would have three age classes, consisting of residual old-growth trees, residual intermediate and suppressed trees, and the understory that would be initiated by opening the canopy.

Where 75 percent retention is prescribed, it is expected that the structural change post-harvest would be only minor and the stand would remain in the old-growth structural stage after harvest and through to the next rotation if unaffected by a major natural disturbance event.

Due to the considerable overstory that would remain in the 50 and 75 percent retention areas, the brushy stage seen after even-aged harvesting would generally not occur. The stem exclusion stage would generally not occur to the same magnitude seen in even-age stands either.

After harvest in the 50 percent retention units, the stands would continue to develop and should regain old-growth characteristics quickly if unaffected by a major natural disturbance event. As noted above, 75 percent retention units should maintain old-growth structure.

**Two-aged Management:**

In Alternative 4 only, two-aged management is prescribed for some units. Where two-aged management is prescribed, at least 60 percent of the existing stand would remain as old growth at this time. A patchwork of openings up to about 5 acres in size would be dispersed throughout the stand. These areas would regenerate as homogenous young growth the same as with even-aged management except on a smaller scale. There would be few if any dispersed old-growth trees within the harvest patches. After about 40 years, or at a time when the young growth from this first harvest has been pre-commercially thinned and the slash from that treatment does not limit wildlife movement, a second harvest would occur that removes the remaining old growth in the stand. After this time, the entire stand would have characteristics of even-aged stands but with two distinct age classes present. Harvest entries would continue in this fashion over time. At least 40 percent of the stand would always have trees old enough to provide cover for wildlife.

The patch openings would naturally grow through a number of structural changes in the future, similar to what is described for even-aged management above.

### *Alternatives 3, 4, and 5 Young-growth Treatment*

Where a uniform crown thin prescription is prescribed in young-growth stands, the canopy of the stands would be opened up allowing more light to reach the forest floor. Trees would generally be evenly spaced across the stand. The stand structure would be expected to change from stem exclusion to more like understory re-initiation. Residual trees would receive more direct sunlight and most defective codominant and dominant trees would be removed from the stand.

Understory vegetation would re-establish. Some natural regeneration of conifer (primarily hemlock) would occur.

The diameter growth on dominant and codominant trees would increase. Epicormic branching would likely occur to some extent on the Sitka spruce but is expected to be minimal.

The CMAI and the 95 percent CMAI would be achieved, on average, approximately 5 to 10 years later than in an untreated stand (Tetra Tech and Stuntzner 2011a, 2011b). The growth rate will temporarily be less than the untreated stands due to trees being removed; however, the rate increases and maintains over time, while the untreated stands see a significant decrease in growth after approximately age 110.

Where a systematic thin prescription is prescribed in young-growth stands, the canopy of the stands would be opened up, allowing more light to reach the forest floor. There would be a mosaic of stand structures including small openings with understory initiation, thinned stands with understory re-initiation, and unthinned stands in stem exclusion.

Understory vegetation would increase for a period of time within the corridor cuts and along the edges of the corridors. Natural regeneration of conifer would occur within the corridor cut (likely proportional to the corridor width) and, to a lesser extent, on each side of the corridor cut. In 20 to 25 years, it is expected that the corridor-cut areas would enter a stem exclusion stage as the regeneration developed without any further treatment to control stand density. These corridors could be pre-commercially thinned if necessary.

## Direct and Indirect Effects on Forest Health and Productivity

### *Alternative 1*

Under Alternative 1 no new timber harvest is planned. It is expected that forest growth would continue to be offset by decay. Insect and disease processes would persist at approximately current levels but due to the general lack of thrift, the forest remains at risk and vulnerable to insect and disease attack. Hemlock dwarf mistletoe, where present, would remain in the stand and may infect hemlock stems that regenerate in the gaps adjacent to infected overstory trees.

No commercial thinning of young-growth would occur in the project area. These stands would remain in a stem exclusion stage. The relatively small spacing between each tree causes stress that would allow for insects and diseases to more easily spread, and the productivity of the stand would be less than its potential due to this overcrowding. There would also be a forfeiture of any opportunity to remove trees with high amounts of defect, such as hemlock fluting. These trees may out-compete nearby trees with little defect, reducing the economic potential for future harvest.

There would be no noticeable increase or decrease in the productivity of the stand for the production of timber products except that stands that were never pre-commercially thinned would have significantly fewer merchantable sized stems at potential rotation age. Abundance of non-merchantable stems reduces the economic feasibility of harvesting and decreases the opportunity for a future timber supply. At some point in the future it is expected that some stands in the project area would experience larger-scale damage from a severe storm event, leading to the regeneration of those stands. Diseases present in trees that remain standing would likely infect the new stand to some degree.

### *Alternatives 2, 3, 4, and 5 Old-growth Harvest*

Where even-aged management is prescribed, the productivity of the stand for timber production would be maximized. The risk of insect, disease, and decay within the newly established growing timber crop would be minimized. The new trees that regenerate after even-aged treatments would be vigorous and free from decay. The insect and disease processes at work in the stands previous to harvest, including hemlock dwarf mistletoe, would be mostly eliminated.

Where uneven-aged management is prescribed, forest health concerns can be used as factors to determine which trees to harvest. An attempt would be made to remove the trees that pose the greatest risk to the health of the new stand, but it would have to be balance with maintaining an economic sale, as well as meeting wildlife objectives. Due to the amount of disease and decay found within the old-growth stands proposed for harvest and constraints for visuals, economics, and wind risk, it is unlikely that all or even a significant proportion of the trees with disease and decay would be removed. Productivity of these stands would be reduced in proportion to the amount of old trees that remain and occupy growing space.

In uneven-aged management stands, there would be a risk of the new stands being infected with the same diseases and decays present in the stands at harvest. This risk would generally be proportional to the amount of basal area retained. Decay organisms would be transferred between trees when decay-ridden trees fall and strike adjacent healthy trees either during harvesting operations or during weather events post-harvest. Hemlock dwarf mistletoe would remain in the stand and likely infect the hemlock regeneration even with selection criteria favoring the removal of infected overstory trees first. The larger old trees retained for wildlife would be of low vigor. These trees are not expected to grow or change in any way as a result of the growing space created by harvest. These trees would occupy space and restrict the regeneration of new trees.

Under two-aged management, timber production would be increased over uneven-aged management but not maximized to the extent that it would be under even-aged management. This is because of the time the larger portion of the stand would remain in old growth as compared to even-aged management where the entire stand would be immediately converted to young growth. Old growth in the project is in decline with decay often exceeding growth in a number of stands.

Two-aged management does, however, address most concerns for insects and disease. The openings created under this harvest entry are large enough to function much the same as with even-aged management; that is, mostly removing the insect and disease processes at work previous to harvest. Hemlock dwarf mistletoe may be more prominent in two-aged stands than in even-aged stands based on the increased edge associated with smaller openings.

### *Alternatives 2, 3, 4, and 5 Young-growth Treatment*

Where a uniform crown thin or systematic corridor thin prescription is used in young-growth stands, stresses on trees due to overcrowding would be reduced. Trees would be better spaced, and individual trees that exhibit signs of disease or decay would be a priority for removal. Commercial thinning requires careful planning and implementation to avoid bole wounding and root damage to the residual crop trees. Some trees would likely be injured regardless. These wounds may attract insects such as bark beetles, and would be places for decay organisms to enter the tree. When conducted correctly, commercial thinning would promote stand health and disease resistance long term by removing any diseased trees and opening growing space that reduced competition stress and mortality. Uniform thinning treatment would carry a greater risk for residual tree injury compared to systematic thinning. Stand mortality caused by overcrowding would decrease in the thinned portion of the stand. Stands are expected to be more resistant to insect and disease infestation. However, injuries to trees resulting from thinning operations, particularly in the uniform thin, could make some trees more susceptible to insects and disease. Stand volumes at harvest age would likely decrease, but tree diameters would be larger and trees would be more resistant to windthrow. Wildlife habitat value of the stand would increase due to increases in understory vegetation and structural diversity.

## Direct and Indirect Effects on Regeneration and Species Composition

### *Alternative 1*

Under Alternative 1, no harvest would occur. Openings in the forest canopy would be created by windthrow and trees falling as a result of decay. Hemlock regeneration would have a competitive advantage over other species when small openings in the canopy occur. At some point in the future, it is expected that some stands in the project area would suffer larger-scale damage from a severe storm event, leading to the regeneration of those stands. Regeneration would likely be prolific with species composition similar to the former stand. Sitka spruce regeneration may have somewhat of a competitive advantage due to soil disturbance from upturned trees. There would be little opportunity to redirect where yellow-cedar is currently growing to more suitable long-term sites.

### *Alternatives 2, 3, 4, and 5 Old-growth Harvest*

Where even-aged management and two-aged management are prescribed, the resulting tree regeneration is expected to be vigorous and representative of the approximate species mix of the former stand. The ability to consistently regenerate cedar after harvest has been raised as a concern. Regeneration survey data shows that tree regeneration in previously harvested areas is comprised on average of about twice as much Sitka spruce, about equal or slightly more cedar and somewhat less hemlock than is estimated to have occurred prior to harvest on a trees per acres basis. Species composition data for the project area shows yellow-cedar representing 3 to 15 percent and redcedar at 3 to 6 percent of the stands, depending on volume strata (for more information on project area species composition, see Table 13 in the Timber and Silviculture Resource Report (Barnhart et al. 2013). Even-aged and two-aged management creates conditions that are favorable for tree planting. There would be a good opportunity to plant yellow-cedar on sites favorable for the long-term survival of the species. These sites often occur where yellow-cedar does not currently exist, and given the slow regeneration of the species, it would be expected to naturally occupy these sites very slowly.

Where uneven-aged management is prescribed, growing space would be limited by the retention of overstory trees. Natural regeneration would occur in the stand in satisfactory amounts; however, the limited openings in the canopy combined with the low ground disturbance of helicopter yarding would favor hemlock regeneration and may limit the regeneration of the cedars and spruce. To offset this, the retention of spruce and cedar advance regeneration would be important. Additionally, smaller-diameter intermediate spruce and cedar trees with good vigor would be important to retain (Deal and Tappeiner 2002). Due to the good species mix and the flexibility of single-tree selection and group selection in the stands proposed for uneven-aged management, it is unlikely that a significant change in species composition would occur. Uneven-aged single tree selection does not offer a good opportunity to plant yellow-cedar due to the heavy residual canopy cover and larger tree competition. Group selection areas would, however, offer a good opportunity, particularly where groups are over 1 acre in size.

#### *Alternatives 3, 4, and 5 Young-growth Treatment*

Where a uniform thin prescription is used in young-growth stands, minor changes to species composition may occur. In general, neither Sitka spruce nor western hemlock is favored and the spruce/hemlock leave trees would be the most vigorous individuals, although individual stand prescriptions may vary based on site specific stand characteristics. Cedars and red alder would generally be retained as much as possible. Because Sitka spruce often represents the most-vigorous and less-defective trees in the stand, it may be selected for retention more frequently than western hemlock.

Where a systematic thin prescription is used in young-growth stands, no significant change in species composition is expected. Trees removed within the corridors would be representative of the species composition of the entire stand. Trees thinned from the matrix near the corridors would be removed as a uniform crown thin, and may cause only slight changes to species composition as described in the uniform thin prescription.

### Direct and Indirect Effects on Windthrow Risk

#### *Alternative 1*

Under the No-action Alternative, stands would remain in a predominantly old-growth condition. Small-scale, frequent disturbance events would continue in the stand until a large-scale event occurs. The inherent windthrow risk within stands would not change appreciably.

No commercial thinning would occur in this alternative. Because of overcrowding, trees would generally have a high height-to-diameter ratio, which would decrease their long-term resistance to windthrow. In the short term, the stand would maintain its dense structure, which decreases the potential for windthrow within the stand.

#### *Alternatives 2, 3, 4, and 5 Old-growth Harvest*

Where even-aged and two-aged management are prescribed, windthrow risk would be eliminated within the harvest unit by the removal of all large trees (Table TBR-4). The future young-growth stands created would typically be more windfirm than the old-growth stands they replace.

Exposed stand edges would, however, have increased risk of windthrow in the first few years after harvest due to the adjacent opening. Clearcuts can increase windthrow hazard by increasing wind speed and turbulence. Most windthrow damage is usually concentrated within the first 30 to 60 feet of the boundary. Above 2 or 3 acres, opening size does not appear to play a significant effect on the amount of windthrow (Stathers et al. 1994).

In two-aged management, the potential for wind damage to stand edges might by slightly higher than under even-aged management because of the increased edge. This may be somewhat offset by the limited opening sizes.

In units where windthrow risk has been determined to be of concern (Table TBR-4), specific measures have been prescribed in the unit cards to reduce or minimize windthrow risk adjacent to unit edges or along stream buffers that protrude into the harvest opening.

Where uneven-aged management is prescribed, the basal area retention requirements were increased to offset the potential for blowdown in high windthrow risk areas. As a result, it is expected that wind risk would remain approximately the same as in the stand prior to harvest. Monitoring results from the Alternatives to Clearcutting Study, 5 years post-harvest in wind-prone areas, reveal approximately 5 percent loss of basal area with the 75 percent basal area retention prescription (McClellan 2007). Based on these results, only minor amounts of windthrow are expected to occur following harvest within proposed uneven-aged management units with high windthrow risk.

**Table TBR-4.** Pre-Harvest Wind Risk Rating by Silvicultural System and Alternative (acres)

| Silvicultural System and Prescription | Wind Risk | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 |
|---|---|---|---|---|---|
| Uneven-Aged with 25% Removal | High | 553 | 927 | 856 | 907 |
| | Moderate | 34 | 102 | 360 | 237 |
| | Low | 9 | 9 | 116 | 92 |
| Two-Age with 40% Removal | High | – | – | 58 | – |
| | Moderate | – | – | 208 | – |
| | Low | – | – | 70 | – |
| Uneven-Aged with 50% Removal | High1/ | – | 69 | 23 | 59 |
| | Moderate | 482 | 947 | 1,858 | 1,334 |
| | Low | 127 | 127 | 229 | 371 |
| Even-Aged Management Clearcut | High | 787 | 1,309 | 341 | 497 |
| | Moderate | 2,386 | 2,852 | 386 | 1,545 |
| | Low | 743 | 776 | 254 | 410 |

1/ Acreage with high wind risk in stands prescribed for uneven-aged management with 50% removal represent settings with lower wind risk that were carved out of larger units with high wind risk ratings.

A mostly unbroken, continuous canopy would remain after harvest in 75 percent retention uneven-aged management units. This would reduce the risk of windthrow along unit edges and adjacent to stream buffers that protrude into the harvest area. In most cases, the uneven-aged prescription would eliminate the need for additional windfirming treatments in RAW zones.

In all even-aged harvest areas, RMAs that have stream channel stability concerns and potential for windthrow were evaluated for RAW. Those RMAs determined to be at risk will be reviewed in the field once preliminary unit boundaries are in place. The specific windfirming prescription for that RMA would be determined at that time.
The regenerated even-aged and two-aged management stands in current high to moderate wind risk areas are expected to be low risk after conversion to even-aged stands. The

lower wind risk in these stands is expected to last through the next rotation (approximately 100 years in the future).

### *Alternatives 2, 3, 4, and 5 Young-growth Treatment*

Where young-growth thinning occurs, windthrow risk would increase immediately after harvest; however, over time, the windfirmness of the stand would increase significantly compared with unthinned stands. This is a result of the lower height-diameter ratios and higher crown ratios in the stand at rotation age, making it more windfirm, especially if partial harvest is desired.

## Cumulative Effects

The analysis area for cumulative effects is the entire Big Thorne project area. The following are the only activities expected to have cumulative effects to forest vegetation.

- Continued micro-sales from the Roadside EA that will occur throughout the project area along existing roads
- Firewood cutting and free use wood removal along existing and proposed roads
- Continued PCT throughout the project area
- Completion of the Control Lake project in the southwestern portion of the project area
- About 600 acres of harvest during the next 5 years on adjacent State lands east and south of Thorne Bay

The Big Thorne project area (including non-NFS lands) has approximately 49,594 acres of young growth resulting from timber harvest and originating mostly from even-aged harvesting. Large-scale timber harvest in the project area began around 1953 and peaked about 45 years ago. The State of Alaska plans to harvest approximately 600 acres of old growth using even-aged management within the next 5 years and about 350 unharvested acres from the Control Lake project that remains could be harvested. Most of this harvest would result in the creation of even-aged forests in addition to that proposed in the Big Thorne Project.

Slight changes in species composition in the project area may occur as a result of harvest operations and follow up treatments such as pre-commercial and commercial thinning. It is expected that Sitka spruce would occur at slightly higher levels than in the former stand due to the excellent regeneration of this species under even-aged management and favoring of this species for crop trees during thinning operations. Conversely, the hemlock component would likely be reduced in proportion to the amount of Sitka spruce in the stand. Hemlock is not considered a favorable crop tree but is usually well represented due to the high numbers of stems available. Both cedar species are expected to be represented in amounts slightly above or approximately the same as their current levels. Planting of Alaska yellow-cedar may be used when necessary (as determined by the District Silviculturist) to maintain its composition in the stand or group of stands and reduce the effects of yellow-cedar decline. Scattered windthrow has occurred along exposed stand boundaries after past harvest and recent road reconstruction activities. Where abrupt stand edges are created, either by timber harvest or road construction, some blowdown would occur. Efforts to minimize blowdown are incorporated in the prescriptions but would not completely eliminate it. Large-scale wind events that significantly modify large areas of old-growth stand structure in the project area may occur in the future regardless of the alternative selected. If events of this magnitude do occur, it is unlikely that measures to assure reasonable windfirmness of stands edges or stream buffers proposed by this project will be effective.

Micro-sales, firewood cutting, and Free Use sawtimber removal will likely occur along existing and proposed roads. Any openings created by removal of these trees would be small and would likely have effects similar to uneven-aged management, single-tree selection timber harvests.

Not all previous harvest areas contain trees 5 feet tall or greater, and therefore do not meet NFMA adjacency requirements. These prior harvest areas are still considered openings for the purposes of scheduling or locating additional created openings (Forest Plan, p. 4-72). Previous harvest unit acreage that did not meet these requirements was added to any adjacent planned harvest unit acreage to ensure that the NFMA maximum opening size was not exceeded. These previous harvest units have not met NFMA requirements because they are recent harvests. These stands are growing and may meet the NFMA adjacency requirements by the time of implementation.

Future PCT would provide an opportunity to maintain stand growth and productivity, improve windfirmness, alter species composition, and promote or maintain understory vegetation growth. PCT of even-aged young growth stands would occur across the Big Thorne project area into the future. Currently, there are a total of approximately 12,300 acres that are expected to need PCT over the next 10 years (M. Sheets 2011). About 1,500 acres of young growth has received NEPA clearance and is currently planned for PCT over the next 5 years in the Big Thorne project area (B. Case, personal comm. 2011).

Prescriptions would be developed to manage for multiple resource values with spacing of leave trees based on site-specific objectives. Prescriptions would maintain a minimum 10-foot buffer adjacent to streams and would often maintain unthinned travel corridors for deer and legacy forest structure patches. In non-development LUDs, prescriptions would often include creation of gaps and retention of unharvested thickets. These treatments may also be considered in development LUDs on a case-by-case basis. Practices for retaining and promoting yellow-cedar will be incorporated into harvest and thinning prescriptions to compensate for the poor regeneration characteristics of the species and yellow-cedar decline.

These future actions, when combined with any of the action alternatives, would result in greater structural diversity of forest stands in the project area and should have negligible overall effects on species composition. As noted under Direct and Indirect Effects, they should have beneficial effects on forest health and productivity.